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Suzuki et al.

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(54) **IMAGE FORMING APPARATUS INCLUDING A REMOVABLE COMPONENT WHICH IS HELD BY HOLDER**

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(51) **Int. Cl.**

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G03G 15/08	(2006.01)
G03G 15/20	(2006.01)
G03G 21/16	(2006.01)

(52) **U.S. Cl.**

CPC ***G03G 21/1633*** (2013.01); ***G03G 21/1647*** (2013.01)

(58) **Field of Classification Search**

CPC G03G 15/0865; G03G 15/0867; G03G 15/1633; G03G 15/2032; G03G 15/2035; G03G 21/16; G03G 21/1623; G03G 21/1633; G03G 21/1647; G03G 21/185

USPC 399/110, 111, 122, 258, 262

See application file for complete search history.

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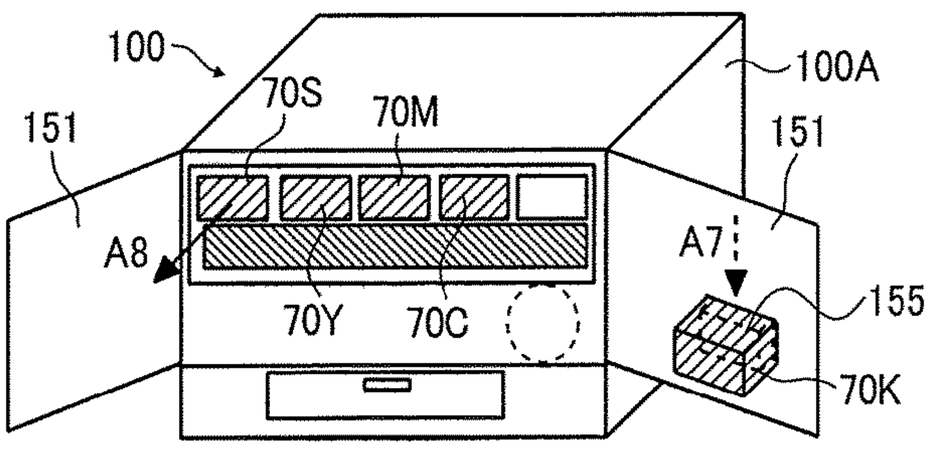
Primary Examiner — William J Royer

(74) *Attorney, Agent, or Firm* — Xsensus LLP

(57) **ABSTRACT**

An image forming apparatus includes an apparatus body, a removable component configured to be removably installed in an installation position in the apparatus body, a cover configured to open and close when the removable component is removed from or installed in the installation position, a replacement removable component configured to be installable in and removable from the installation position in which the removable component is installed, and a holder configured to hold the replacement removable component at a different position from the installation position when the removable component is installed in the installation position and the cover opens. The replacement removable component held by the holder is configured to inhibit the cover from closing.

9 Claims, 8 Drawing Sheets



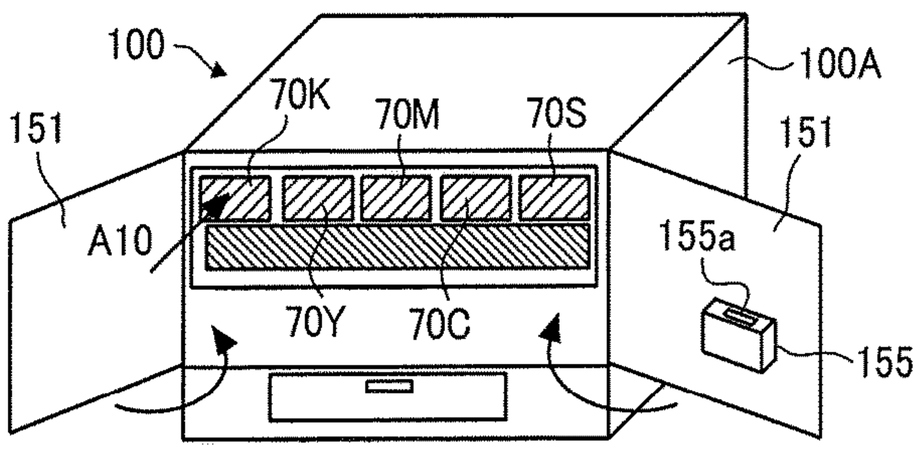


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FIG. 1

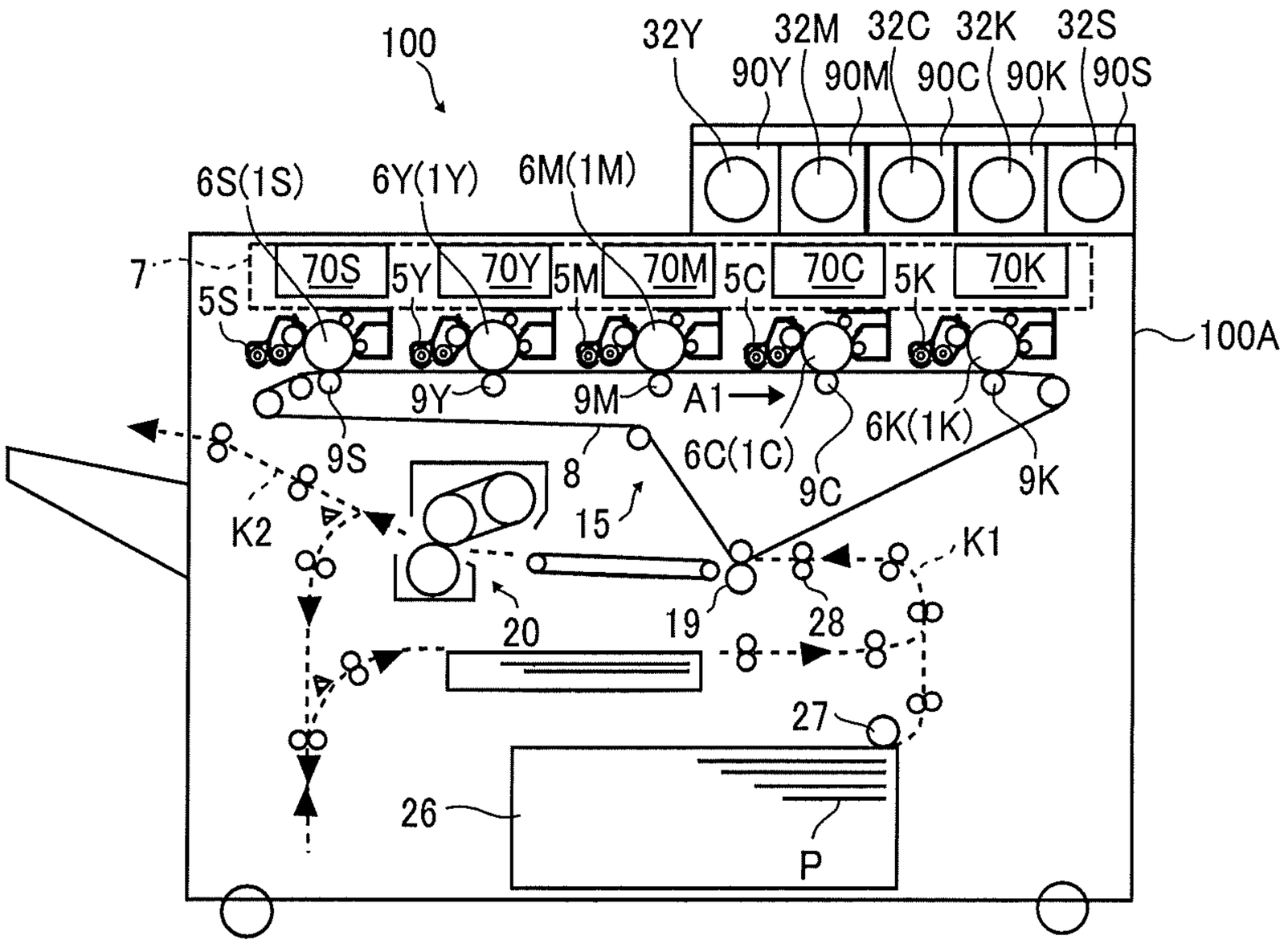
100
32Y
32M
32C
32K
32S
90Y
90M
90C
90K
90S
6S(1S)
6Y(1Y)
6M(1M)
7
70S
5Y
70Y
5M
70M
5C
70C
5K
70K
5S
100A
9Y
9M
A1
6C(1C)
6K(1K)
9S
8
9C
9K
K2
15
K1
20
19
28
27
26
P

FIG. 2

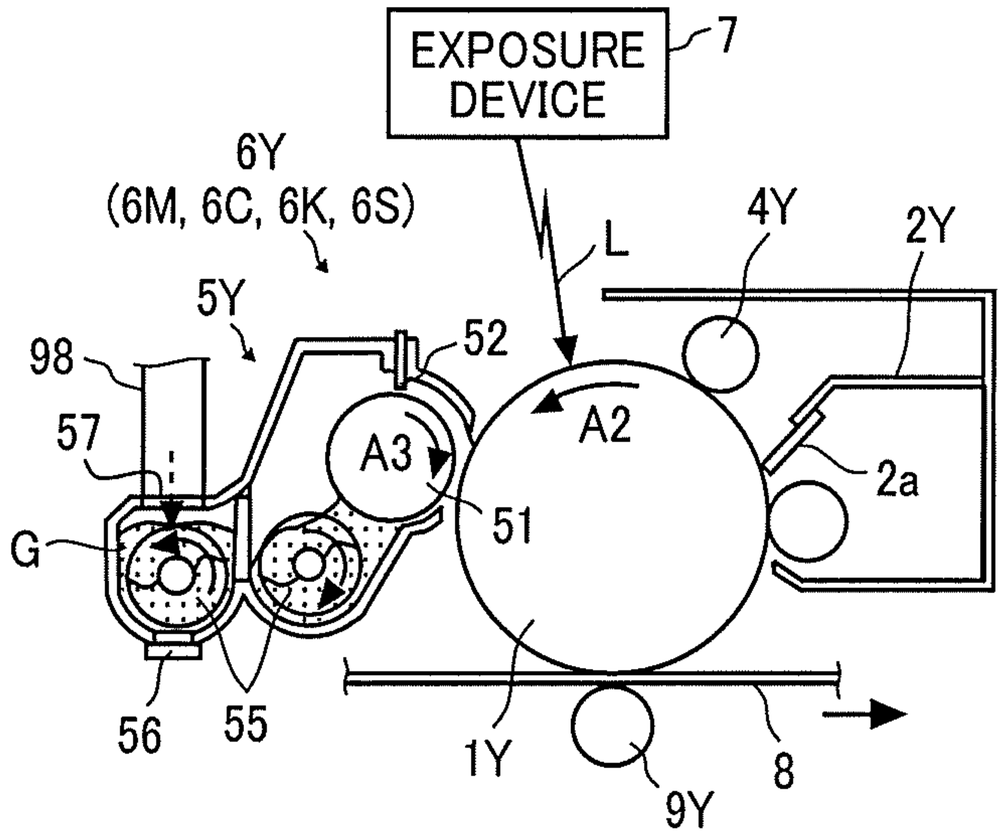
EXPOSURE DEVICE
7
6Y
(6M, 6C, 6K, 6S)
L
4Y
2Y
5Y
98
52
A2
57
A3
2a
51
G
56
55
1Y
9Y
8

FIG. 3

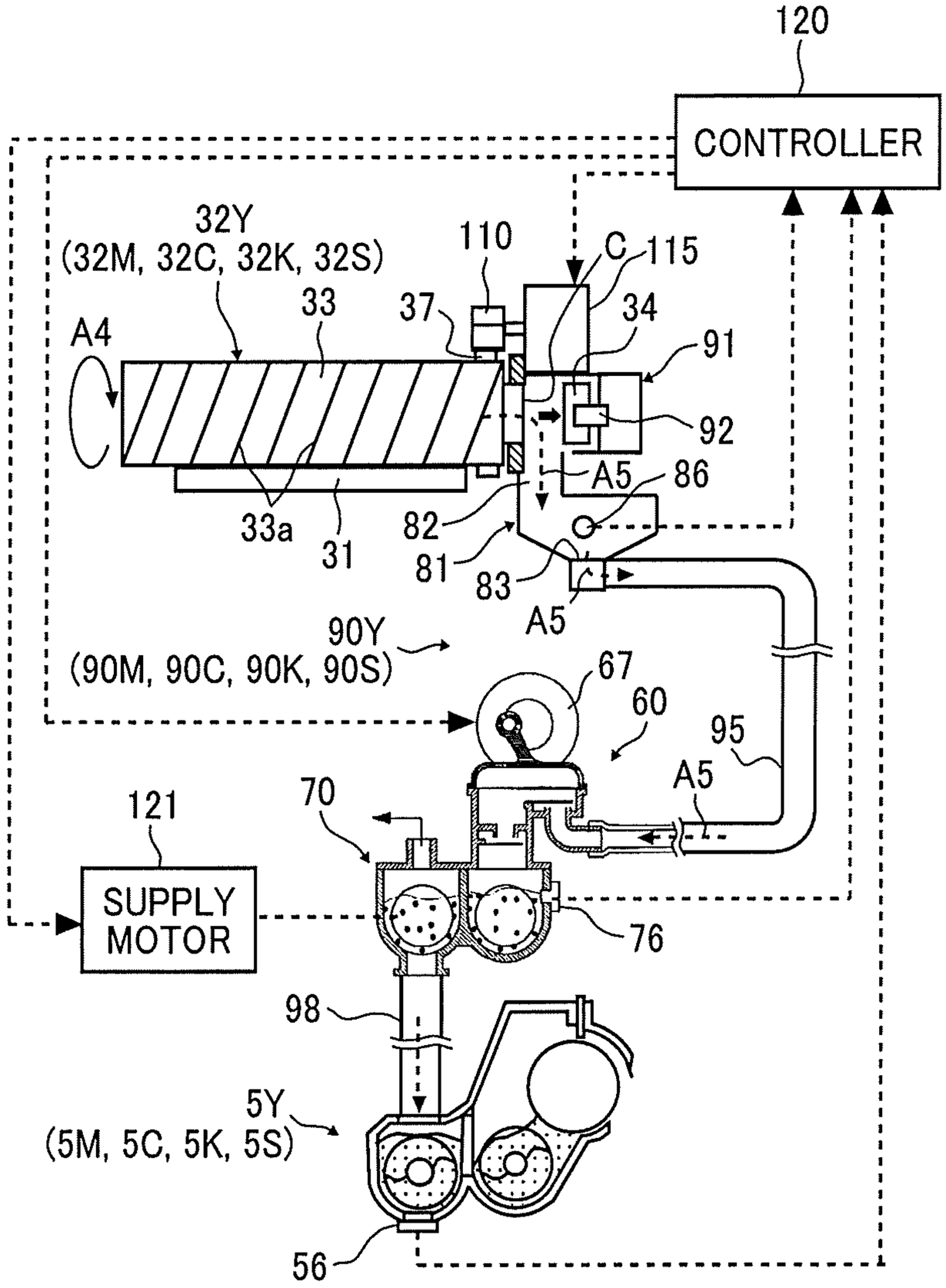
120
CONTROLLER
32Y
(32M, 32C, 32K, 32S)
110
C
115
33
37
34
A4
91
92
A5
86
33a
31
82
81
83
A5
90Y
(90M, 90C, 90K, 90S)
67
60
95
A5
70
121
SUPPLY MOTOR
76
98
5Y
(5M, 5C, 5K, 5S)
56

FIG. 4

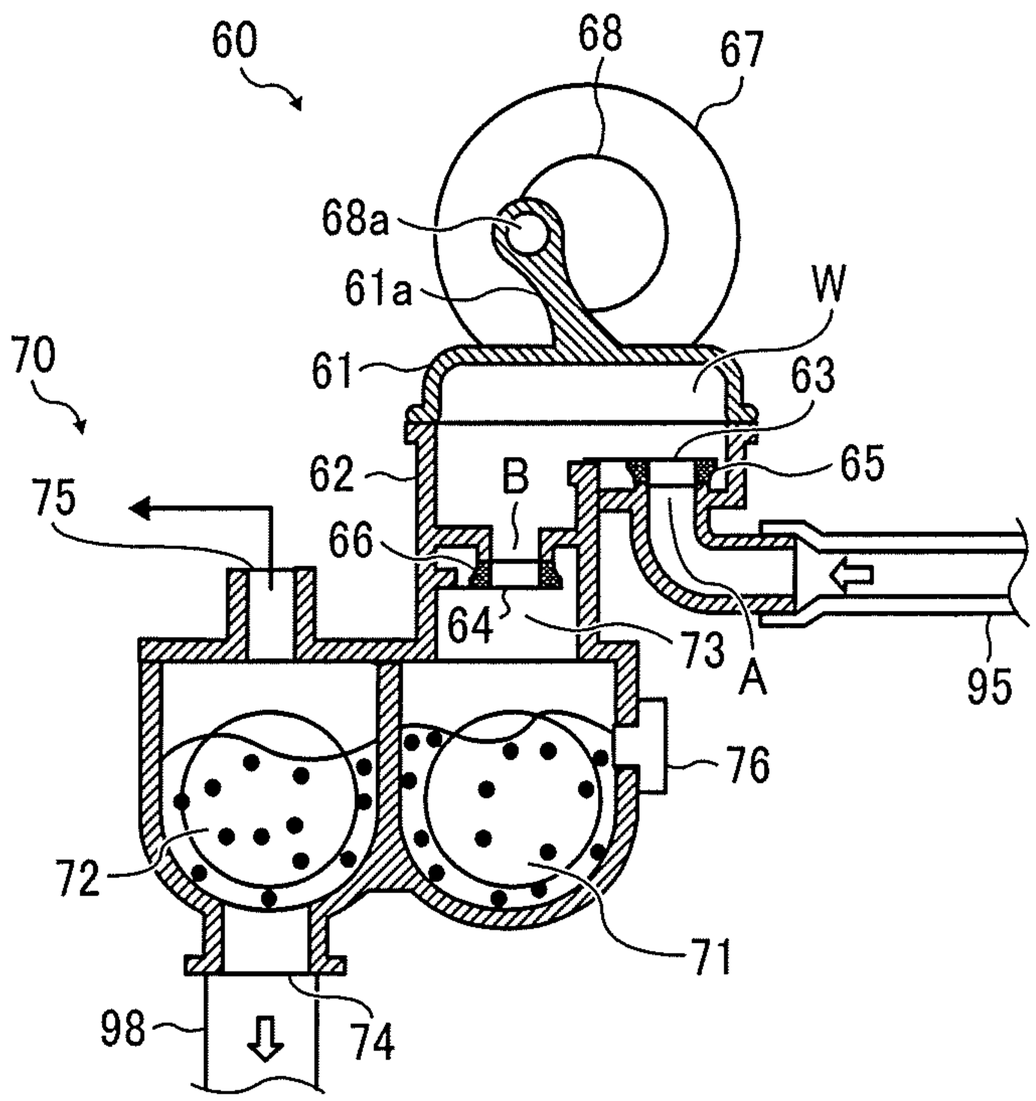
60
68
67
68a
61a
W
70
61
63
62
B
65
75
66
64
73
A
95
76
72
71
98
74

FIG. 5

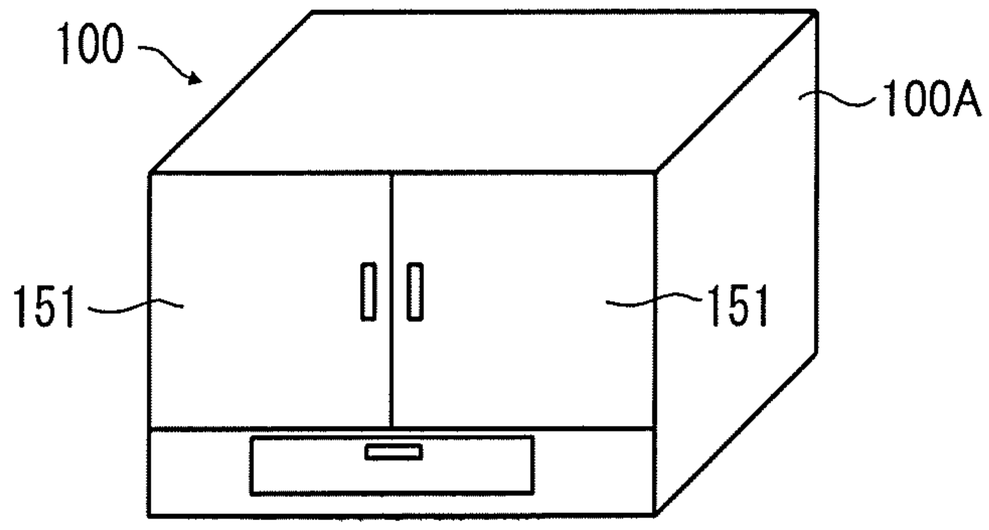
100
100A
151
151

FIG. 6A

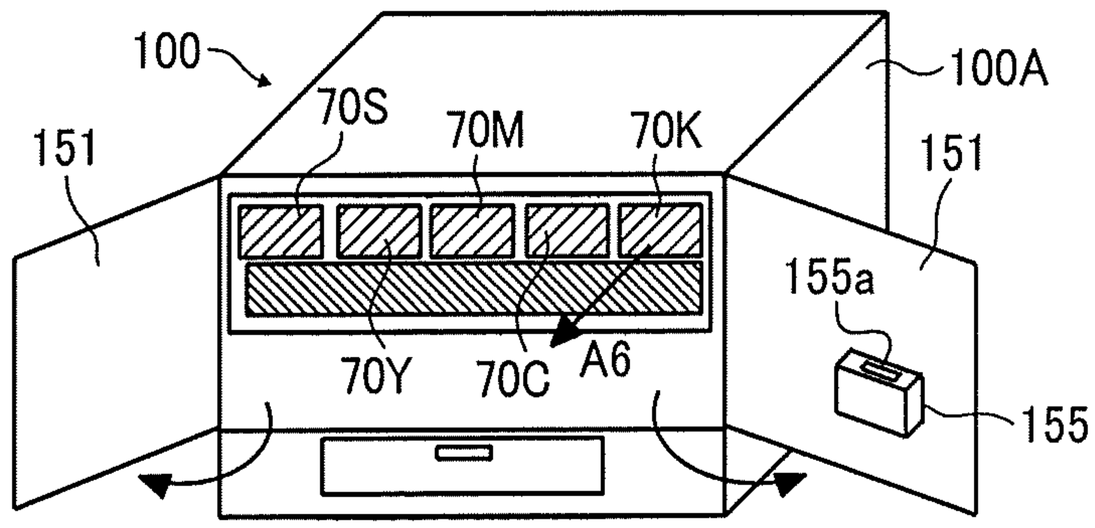

FIG. 6B

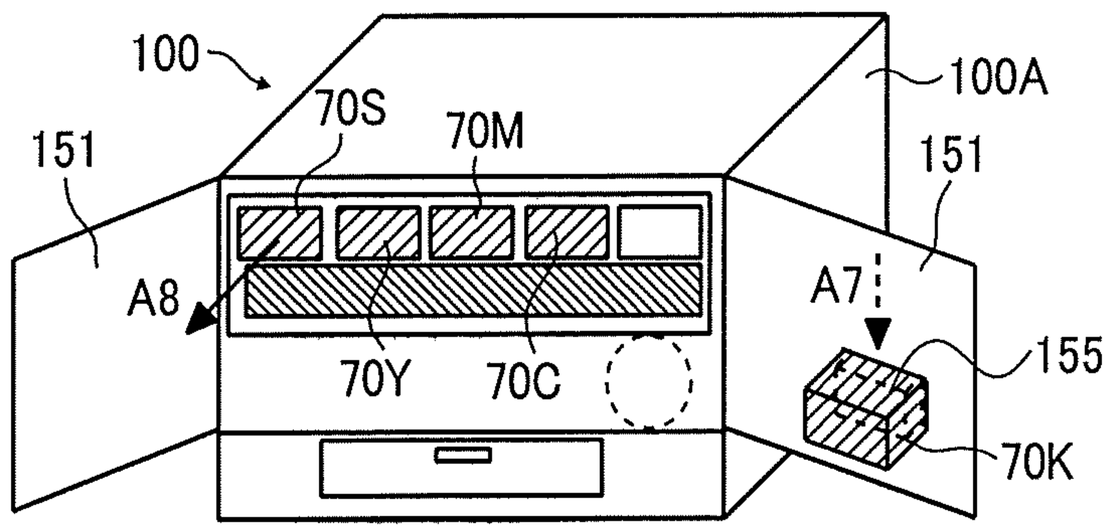

FIG. 6C

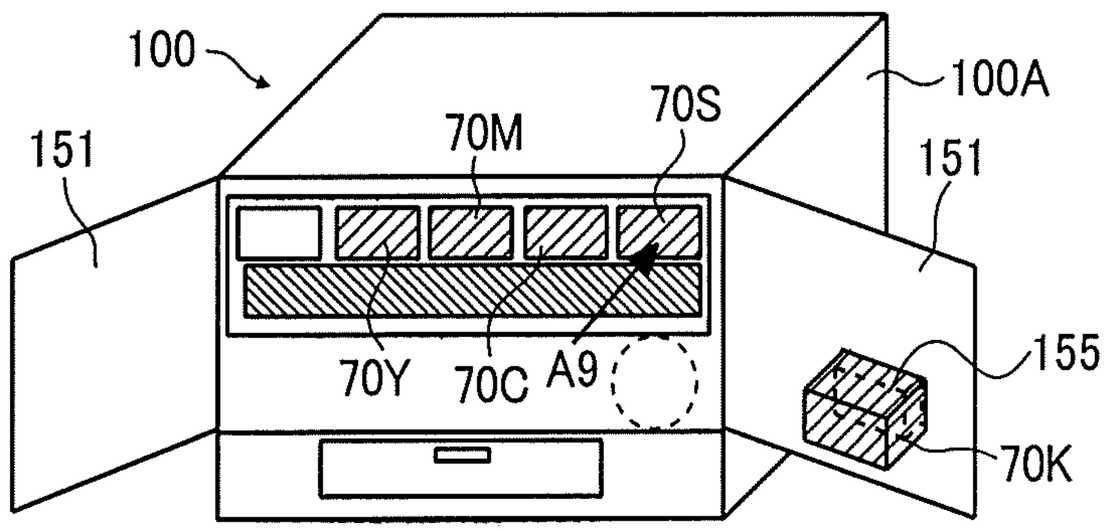

FIG. 6D

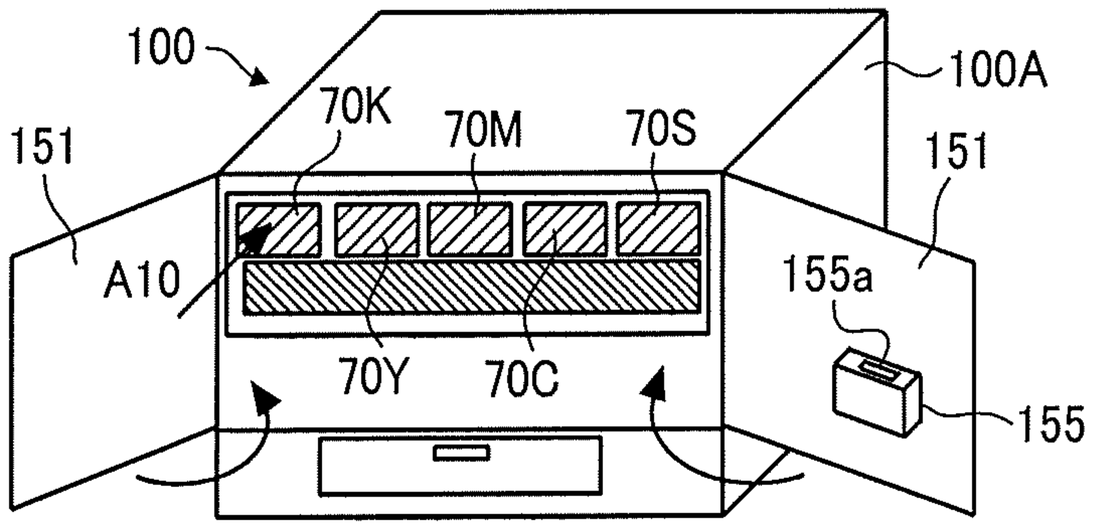

FIG. 7

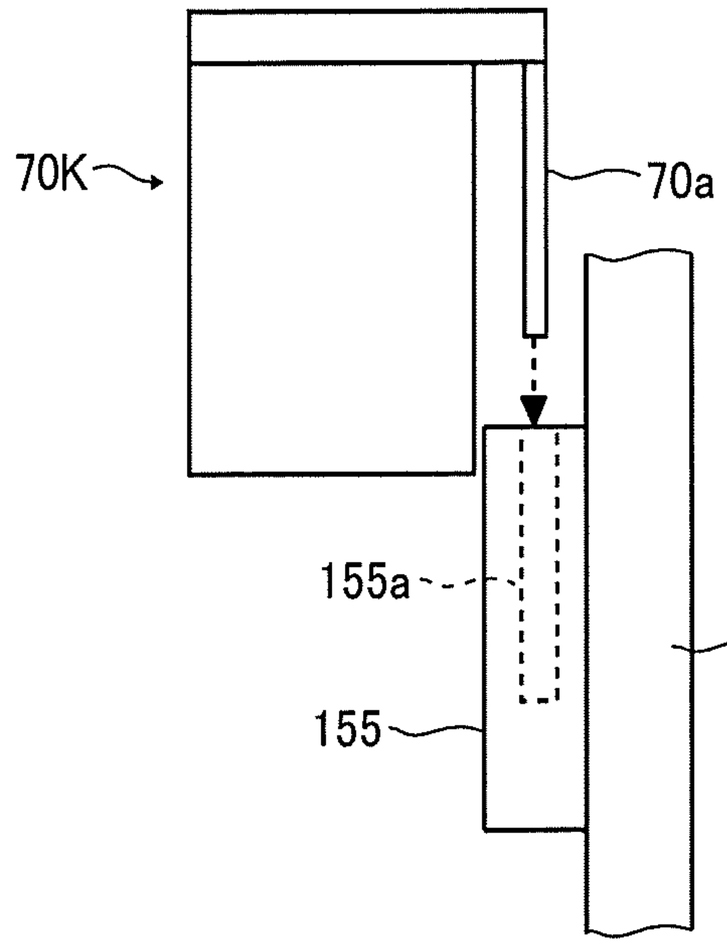

FIG. 8A

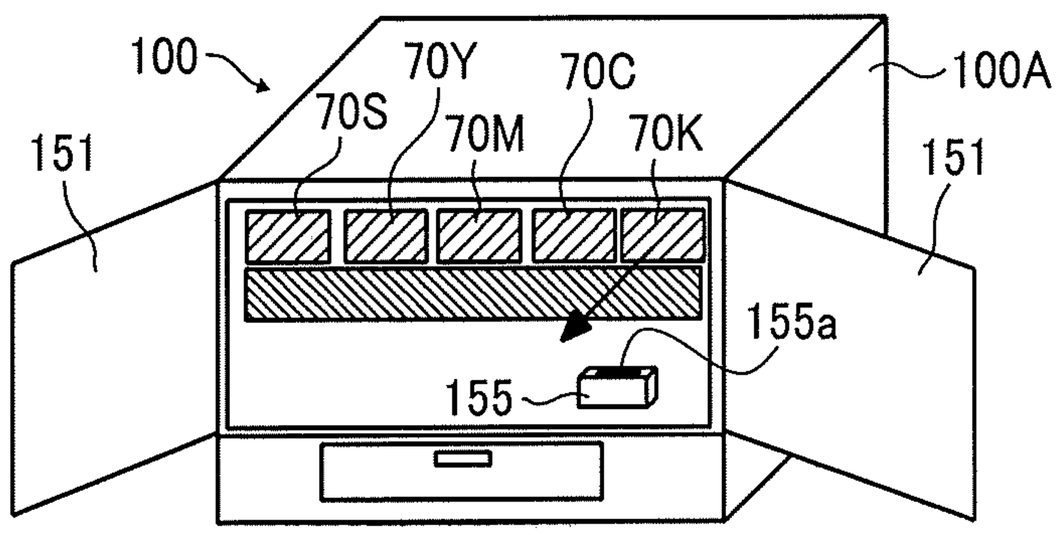

FIG. 8B

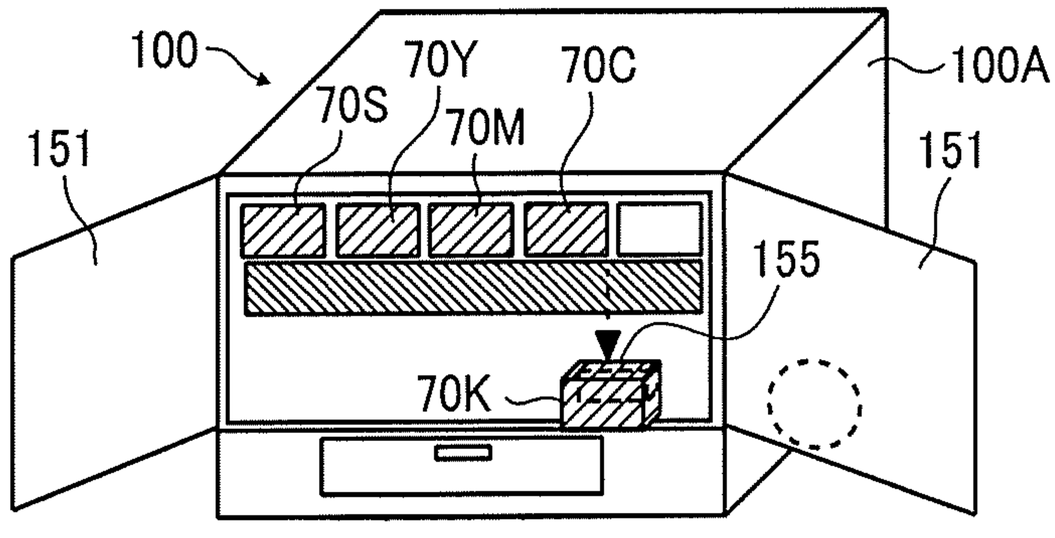

FIG. 9

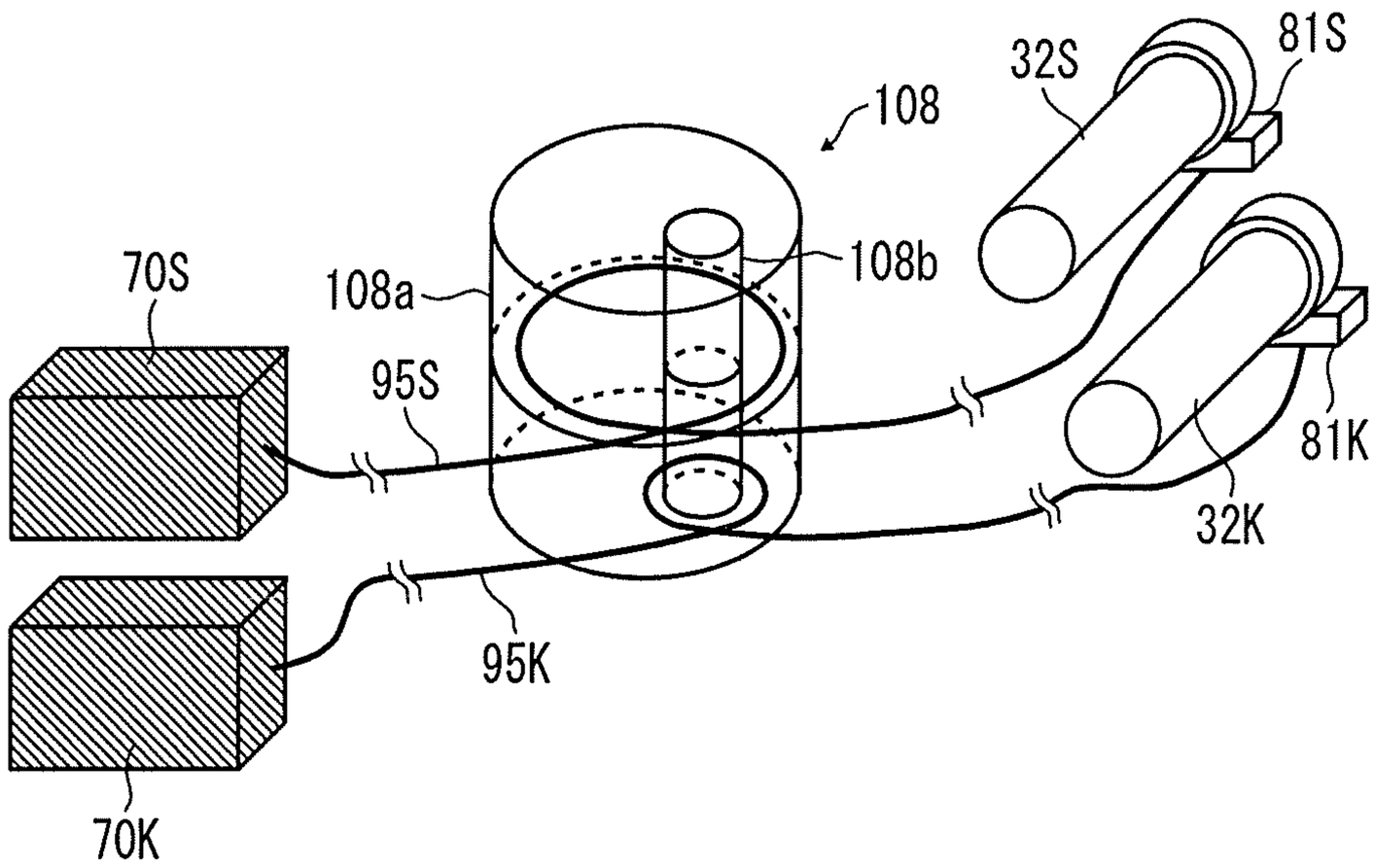

FIG. 10A

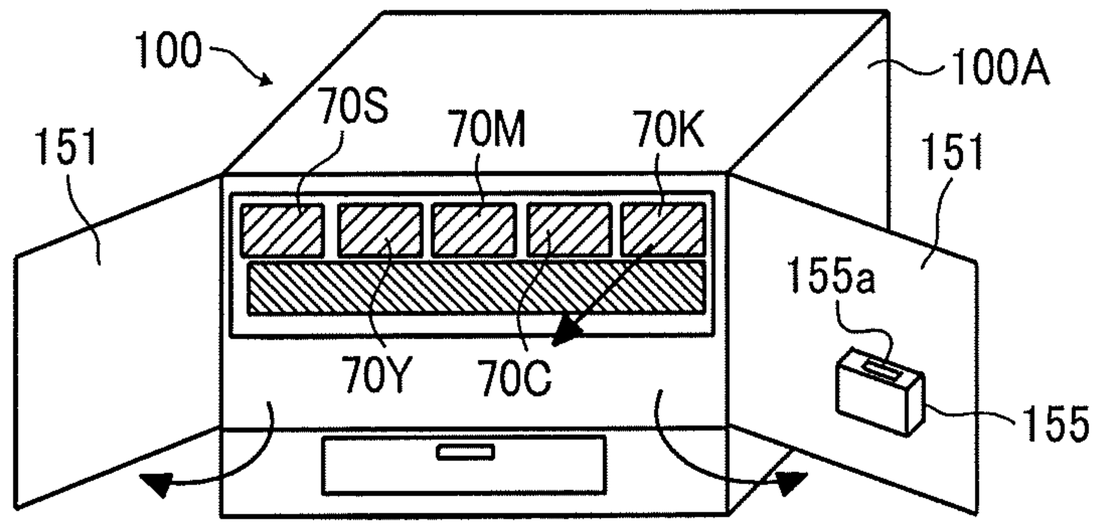

FIG. 10B

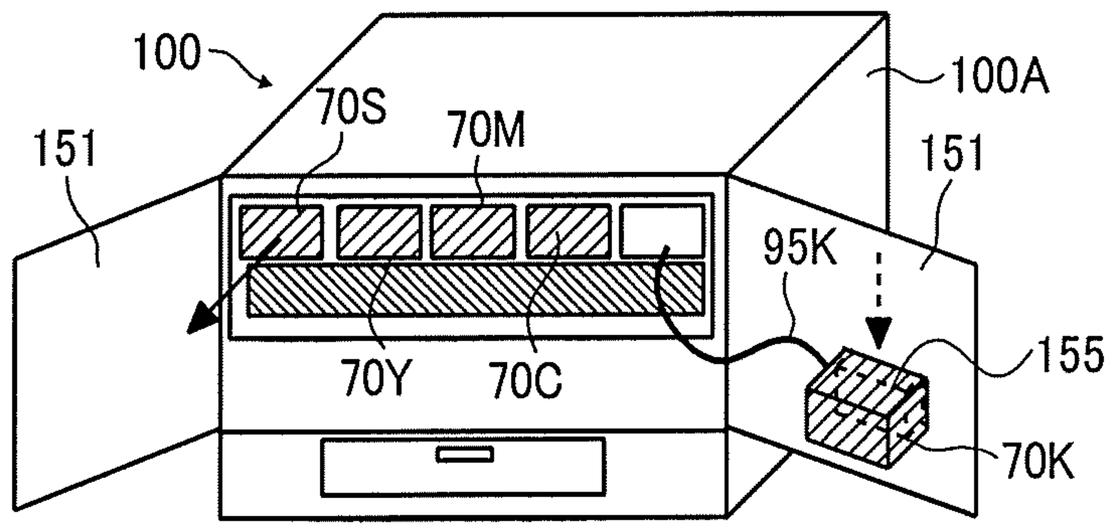

FIG. 10C

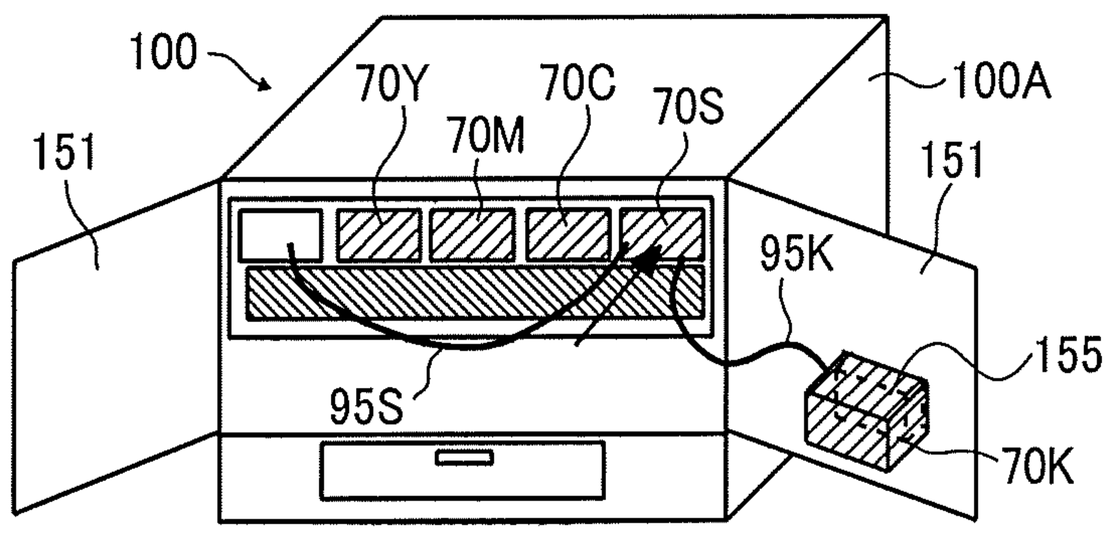

FIG. 10D

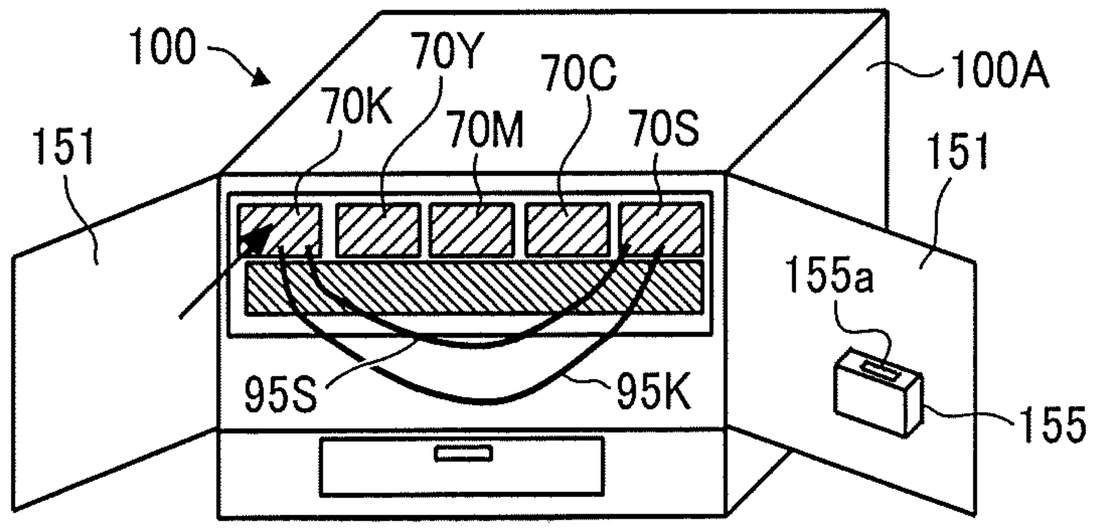

FIG. 11A

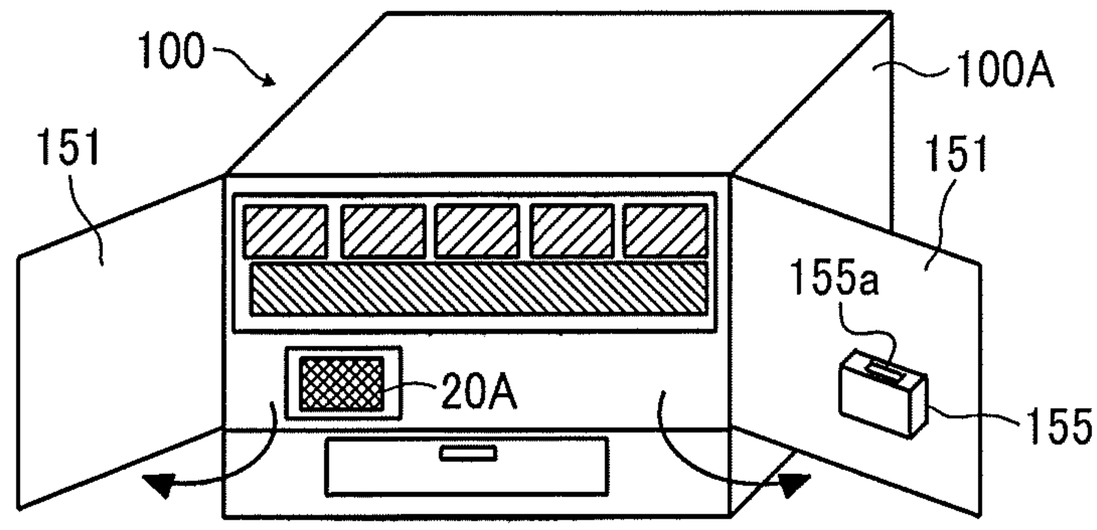

FIG. 11B

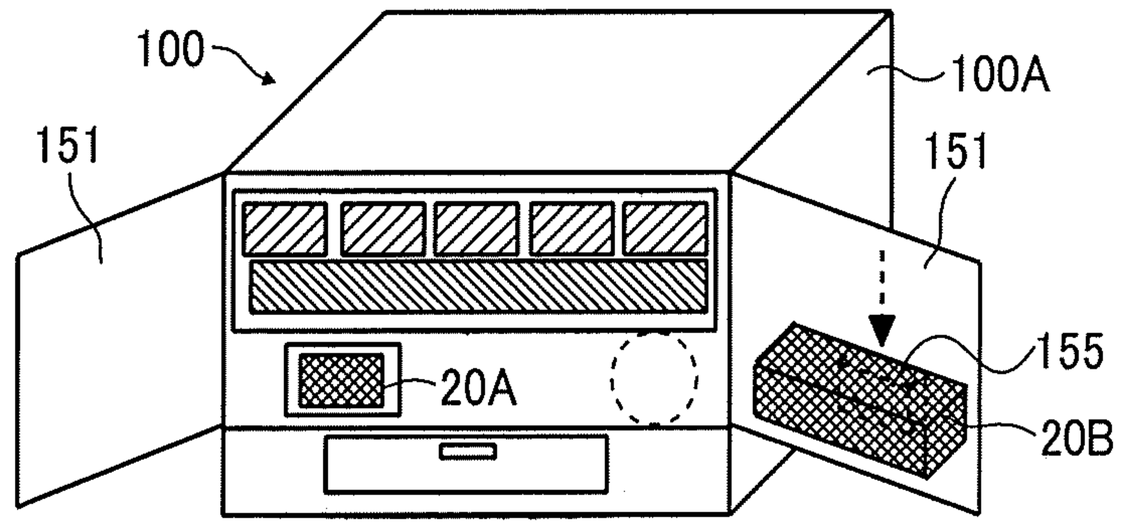

FIG. 11C

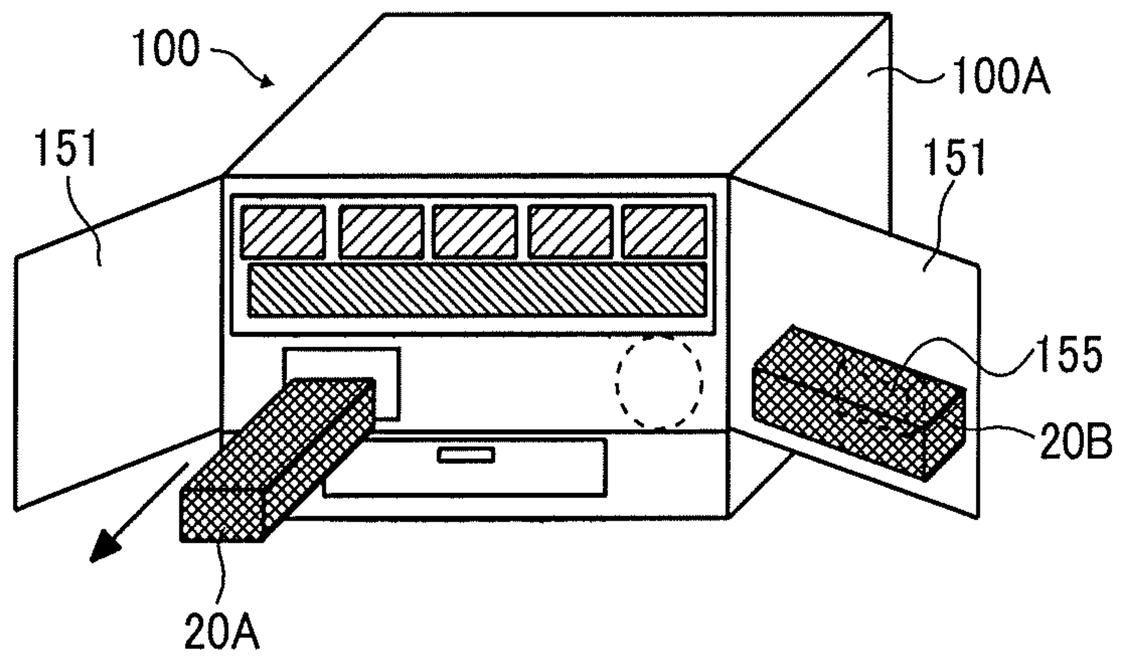

FIG. 11D

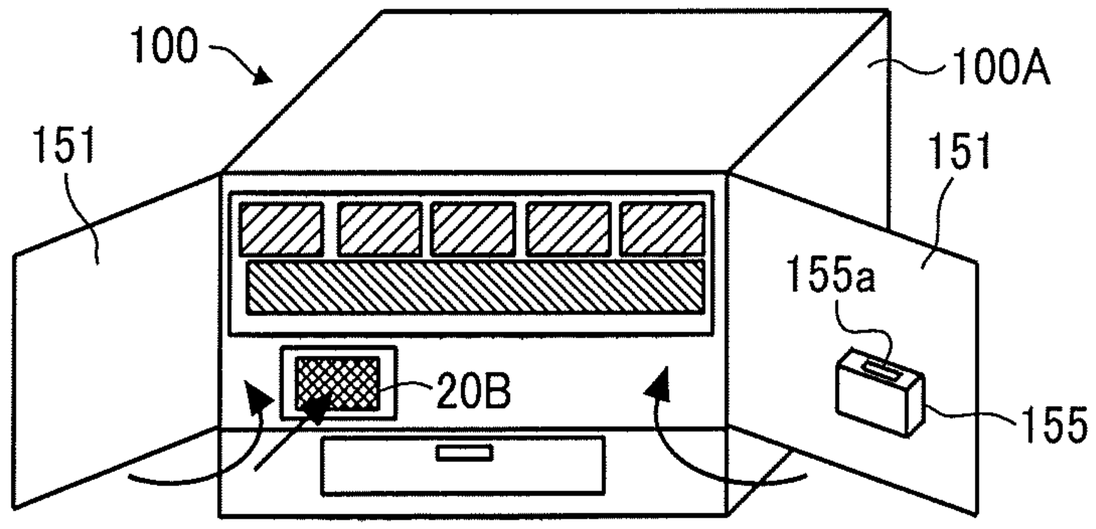

IMAGE FORMING APPARATUS INCLUDING A REMOVABLE COMPONENT WHICH IS HELD BY HOLDER

CROSS-REFERENCE TO RELATED APPLICATION

This patent application is based on and claims priority pursuant to 35 U.S.C. § 119(a) to Japanese Patent Application No. 2018-008970, filed on Jan. 23, 2018, in the Japan Patent Office, the entire disclosure of which is hereby incorporated by reference herein.

BACKGROUND

Technical Field

This disclosure generally relates to an image forming apparatus such as a copier, a printer, a facsimile machine, or a multifunction peripheral (MFP) having at least two of copying, printing, facsimile transmission, plotting, and scanning capabilities.

Description of the Related Art

There have been image forming apparatuses, such as copiers, printers, facsimile machines, or MFPs, that include a removable component, such as a process cartridge, a developing device, and a sub-hopper. The removable component is installable in and removable from an installation position in the image forming apparatus. The removable component is replaced with a replacement removable component in the installation position instead of the removable component for rearranging or simply replacing the removable component.

SUMMARY

According to embodiments of the present disclosure, an improved image forming apparatus includes an apparatus body, a removable component configured to be removably installed in an installation position in the apparatus body, a cover configured to open and close when the removable component is removed from or installed in the installation position, a replacement removable component configured to be installable in and removable from the installation position in which the removable component is installed, and a holder configured to hold the replacement removable component at a different position from the installation position when the removable component is installed in the installation position and the cover opens. The replacement removable component held by the holder is configured to inhibit the cover from closing.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

A more complete appreciation of the disclosure and many of the attendant advantages thereof will be readily obtained as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, wherein:

FIG. **1** is a schematic view illustrating a configuration of an image forming apparatus according to an embodiment of the present disclosure;

FIG. **2** is a cross-sectional view of a process cartridge and vicinity thereof in the image forming apparatus illustrated in FIG. **1**;

FIG. **3** is a schematic view illustrating a configuration of a developer supply device in the image forming apparatus illustrated in FIG. **1**;

FIG. **4** is a cross-sectional view of a conveyance pump and a sub-hopper of the developer supply device in FIG. **3**;

FIG. **5** is a schematic perspective view illustrating an exterior of the image forming apparatus according to an embodiment of the present disclosure;

FIGS. **6**A to **6**D are schematic views illustrating processes of swapping the sub-hoppers according to an embodiment of the present disclosure;

FIG. **7** is a side view illustrating the sub-hopper to engage with a holder attached to a cover according to an embodiment of the present disclosure;

FIGS. **8**A and **8**B are schematic views illustrating a part of processes of swapping the sub-hoppers according to a first variation of the present disclosure;

FIG. **9** is a schematic perspective view illustrating a part of an image forming apparatus according to a second variation of the present disclosure;

FIGS. **10**A to **10**D are schematic views illustrating processes of swapping the sub-hoppers in the image forming apparatus in FIG. **9**; and

FIGS. **11**A to **11**D are schematic views illustrating processes of replacing a fixing device according to a third variation of the present disclosure.

The accompanying drawings are intended to depict embodiments of the present disclosure and should not be interpreted to limit the scope thereof. The accompanying drawings are not to be considered as drawn to scale unless explicitly noted. In addition, identical or similar reference numerals designate identical or similar components throughout the several views.

DETAILED DESCRIPTION

In describing embodiments illustrated in the drawings, specific terminology is employed for the sake of clarity. However, the disclosure of this patent specification is not intended to be limited to the specific terminology so selected, and it is to be understood that each specific element includes all technical equivalents that have the same function, operate in a similar manner, and achieve a similar result.

As used herein, the singular forms "a", "an", and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

It is to be noted that the suffixes Y, M, C, K, and S attached to each reference numeral indicate only that components indicated thereby are used for forming yellow, magenta, cyan, black, special color images, respectively, and hereinafter may be omitted when color discrimination is not necessary.

Embodiments of the present disclosure are described in detail with reference to drawings. It is to be understood that identical or similar reference numerals are assigned to identical or corresponding components throughout the drawings, and redundant descriptions are omitted or simplified below.

Referring to FIGS. **1** and **2**, a configuration and operation of an image forming apparatus **100** according to the present embodiment are described below.

FIG. **1** is a schematic view illustrating a configuration of the image forming apparatus **100**, which in the present embodiment is a printer, for example. FIG. **2** is an enlarged view of a process cartridge **6**Y and vicinity thereof in the image forming apparatus **100** illustrated in FIG. **1**.

As illustrated in FIG. **1**, the image forming apparatus **100** includes an intermediate transfer belt **8** as an intermediate transferor that moves in a predetermined direction of rotation of the intermediate transfer belt **8** indicated by arrow A1 in FIG. **1**, in a center of the image forming apparatus **100**. A plurality of photoconductor drums **1**Y, **1**M, **1**C, **1**K, and **1**S as a plurality of image bearers is disposed facing the intermediate transfer belt **8** and arranged side by side along the direction of rotation of the intermediate transfer belt **8**.

A plurality of developing devices **5**Y, **5**M, **5**C, **5**K, and **5**S is removably installed in the image forming apparatus **100**. The plurality of developing devices **5**Y, **5**M, **5**C, **5**K, and **5**S develops latent images formed on the plurality of photoconductor drums **1**Y, **1**M, **1**C, **1**K, and **1**S (the plurality of image bearers) with different colors, respectively.

As illustrated in FIG. **1**, a plurality of toner containers **32**Y, **32**M, **32**C, **32**K, and **32**S as a plurality of developer containers contains toners of different colors as developer therein and is removably installed in an upper portion of the image forming apparatus **100**.

A plurality of developer supply devices **90**Y, **90**M, **90**C, **90**K, and **90**S is installed in the image forming apparatus **100** to supply the toners contained in the plurality of toner containers **32**Y, **32**M, **32**C, **32**K, and **32**S to the plurality of developing devices **5**Y, **5**M, **5**C, **5**K, and **5**S, respectively. Referring to FIG. **3**, the plurality of developer supply devices **90**Y, **90**M, **90**C, **90**K, and **90**S includes a cap holder **91**, a reservoir **81**, a conveyance pump **60**, a sub-hopper **70**, a tube **95**, and a conveyance pipe **98**.

More specifically, the five toner containers **32**Y, **32**M, **32**C, **32**K, and **32**S (the developer containers), which are substantially cylindrical in the present embodiment, are removably installed in the developer supply devices **90**Y, **90**M, **90**C, **90**K, and **90**S (the toner supply device), respectively.

As illustrated in FIG. **1**, the toner container **32**S (and the developer supply device **90**S) for special color is disposed on the rightmost side of the toner containers **32**Y, **32**M, **32**C, **32**K, and **32**S. The toner container **32**K (and the developer supply device **90**K) for black is disposed on the left side of the toner container **32**S. On the left side of the toner container **32**K, the toner containers **32**Y, **32**M, and **32**C (and the developer supply devices **90**Y, **90**M, and **90**C) corresponding to three colors (yellow, magenta, and cyan) are disposed in order of cyan, magenta, and yellow from the right.

In particular, the toner container **32**S for special color is often replaced with a toner container **32**S for another type of special color depending on usage before all of the toner contained therein is consumed. Accordingly, the toner container **32**S is replaced more frequently than the other toner containers **32**Y, **32**M, **32**C, and **32**K are.

Referring to FIG. **1**, the developer supply device **90**K for black supplies black toner (developer) contained in the toner container **32**K (the developer container) for black to the developing device **5**K for black.

In addition, the three developer supply devices **90**Y, **90**M, and **90**C for yellow, magenta, and cyan supply color toners of yellow, magenta, and cyan (developers) contained in the toner containers **32**Y, **32**M, and **32**C (the developer containers) for colors to the developing devices **5**Y, **5**M, and **5**C for colors, respectively.

The developer supply device **90**S for special color supplies special color toner (developer) contained in the toner container **32**S (the developer container) for special color to the developing device **5**S for special color.

Any toner can be used as the black toner; the color toner of each of yellow, magenta, and cyan; or the special color toner.

In particular, the special color toner is different from the black toner and the color toner, and any clear toner (transparent toner, colorless toner, achromatic toner, no-pigment toner, or the like), white toner, or the like can be used depending on usage.

Referring to FIG. **1**, an exposure device **7** and sub-hoppers **70**Y, **70**M, **70**C, **70**K, and **70**S (also collectively referred to as sub-hoppers **70** unless distinguished) are disposed in an upper section of the image forming apparatus **100**, and process cartridges **6**Y, **6**M, **6**C, **6**K, and **6**S, including the developing devices **5**Y, **5**M, **5**C, **5**K, and **5**S, corresponding to yellow, magenta, cyan, black, and special color are disposed side by side under the exposure device **7**, facing an intermediate transfer device **15** including the intermediate transfer belt **8**.

As illustrated in FIG. **1**, in a basic arrangement, the five process cartridges **6**Y, **6**M, **6**C, **6**K, and **6**S, including the developing devices **5**Y, **5**M, **5**C, **5**K, and **5**S, are disposed in the order of the process cartridge **6**S (the developing device **5**S) for special color, the process cartridge **6**Y (the developing device **5**Y) for yellow, the process cartridge **6**M (the developing device **5**M) for magenta, the process cartridge **6**C (the developing device **5**C) for cyan, and the process cartridge **6**K (the developing device **5**K) for black from upstream in the direction of rotation of the intermediate transfer belt **8** (hereinafter, referred to as a rotation direction).

The five sub-hoppers **70**Y, **70**M, **70**C, **70**K, and **70**S are arranged in the same order as the process cartridges **6**Y, **6**M, **6**C, **6**K, and **6**S (the developing devices **5**Y, **5**M, **5**C, **5**K, and **5**S). The five sub-hoppers **70** are united with five conveyance pumps **60** for yellow, magenta, cyan, black, and special color, respectively.

However, the arrangement order (the arrangement) is appropriately variable depending on usage. With such a configuration, an optimum image can be formed depending on usage. The arrangement is changed with components of the same color, such as the developing device **5**, the sub-hopper **70**, the conveyance pump **60**, and the like, so that toners of different colors are not mixed in the developing device **5** or the sub-hopper **70** (color mixing does not occur).

It can be seen that, in the present embodiment, the sub-hopper **70**K, the conveyance pump **60**K, and the process cartridge **6**K (the developing device **5**K) for black and the sub-hopper **70**S, the conveyance pump **60**S, and the process cartridge **6**S (the developing device **5**S) for special color can be swapped.

The present embodiment is featured in swap process of the sub-hopper **70**K for black and the sub-hopper **70**S for special color, which is described in detail later with reference to FIG. **6**A-**6**D.

The special color toner is not limited to one type, and in many cases, different types of toner containers **32**S for special colors are installed depending on usage as necessary. For example, the toner container **32**S for clear toner may be replaced with the toner container **32**S for white toner.

In such a case, depending on the type of special color toner, the process cartridge **6**S (the developing device **5**S) for special color is preferably moved from an extreme upstream installation position to an extreme downstream installation position in the rotation direction of the intermediate transfer belt **8**. For example, the clear toner as the special color toner is often used for improving the glossiness of an image, and it is desirable that the clear toner be

primarily transferred onto the intermediate transfer belt **8** first. Accordingly, as illustrated in FIGS. **1**, the process cartridge **6**S (the developing device **5**S) for special color is disposed at the extreme upstream installation position in the rotation direction of the intermediate transfer belt **8**. Meanwhile, the white toner as the special color toner is often used for forming an image on a colored sheet P that is not white, and it is desirable that the white toner be secondarily transferred in the lowermost layer on a sheet P. Accordingly, the process cartridge **6**S (the developing device **5**S) for special color is disposed at the extreme downstream installation position in the rotation direction of the intermediate transfer belt **8**. With the rearrangement of the installation position of the process cartridge **6**S (the developing device **5**S) for special color, the installation position of the process cartridge **6**K (the developing device **5**K) for black is replaced with the installation position of the process cartridge **6**S (the developing device **5**S). With such a rearrangement of the installation position of the process cartridges **6**S and **6**K (the developing devices **5**S and **5**K), the sub-hopper **70**S (and the conveyance pump **60**S) for special color and the sub-hopper **70**K (and the conveyance pump **60**K) for black are swapped.

Users or service engineers manually perform the rearrangement operation according to procedures displayed on a control panel disposed on the exterior of the image forming apparatus **100**.

Referring to FIG. **2**, the process cartridge **6**Y for yellow is a single-piece removable component removably installed in the image forming apparatus **100**, includes the photoconductor drum **1**Y as the image bearer, and further includes a charger **4**Y, the developing device **5**Y, and a cleaner **2**Y disposed around the photoconductor drum **1**Y. Image forming processes, namely, charging, exposure, development, transfer, and cleaning processes are performed on the photoconductor drum **1**Y, and thus a yellow toner image is formed on the photoconductor drum **1**Y.

Note that, the other process cartridges **6**M, **6**C, **6**K, and **6**S have a similar configuration to the process cartridge **6**Y for yellow except the color of the toner used therein and form magenta, cyan, black, and special color toner images, respectively. Thus, only the process cartridge **6**Y is described below and descriptions of other process cartridges **6**M, **6**C, **6**K, and **6**S are omitted.

Referring to FIG. **2**, the photoconductor drum **1**Y as the image bearer is rotated counterclockwise indicated by arrow A**2** in FIG. **2** by a driving motor. The charger **4**Y uniformly charges a surface of the photoconductor drum **1**Y at a position opposite the charger **4**Y (a charging process).

When the surface of the photoconductor drum **1**Y reaches a position to receive a laser beam L emitted from the exposure device **7** (i.e., a writing device), the photoconductor drum **1**Y is scanned with the laser beam L, and thus an electrostatic latent image for yellow is formed on the surface of the photoconductor drum **1**Y (an exposure process).

Then, the surface of the photoconductor drum **1**Y reaches a position facing a developing roller **51** of the developing device **5**Y, where the electrostatic latent image is developed with toner into a yellow toner image (a development process).

When the surface of the photoconductor drum **1**Y carrying the toner image reaches a position facing a primary transfer roller **9**Y via the intermediate transfer belt **8**, the toner image on the photoconductor drum **1**Y is transferred onto the intermediate transfer belt **8** (a primary transfer process). After the primary transfer process, a certain amount of untransferred toner remains on the photoconductor drum **1**Y.

When the surface of the photoconductor drum **1**Y reaches a position facing the cleaner **2**Y, a cleaning blade **2***a* collects the untransferred toner from the photoconductor drum **1**Y into the cleaner **2**Y (a cleaning process).

Subsequently, the surface of the photoconductor drum **1**Y reaches a position facing a discharger, and the discharger eliminates a residual potential from the photoconductor drum **1**Y.

Thus, a series of image forming processes performed on the photoconductor drum **1**Y is completed.

The above-described image forming processes are performed in the process cartridges **6**M, **6**C, **6**K, and **6**S similarly to the process cartridge **6**Y for yellow. That is, the exposure device **7** irradiates the photoconductor drums **1**M, **1**C, **1**K, and **1**S of the process cartridges **6**M, **6**C, **6**K, and **6**S with the laser beams L based on image data. Specifically, the exposure device **7** includes light sources to emit the laser beams L, multiple optical elements, and a polygon mirror that is rotated by a motor. The laser beams L are directed to the respective photoconductor drums **1**Y, **1**M, **1**C, **1**K, and **1**S via the multiple optical elements while being deflected by the polygon mirror.

Then, the toner images formed on the respective photoconductor drums **1**Y, **1**M, **1**C, **1**K, and **1**S through the development process are primarily transferred and deposited one on another onto the intermediate transfer belt **8**. Thus, a desired multicolor toner image is formed on the intermediate transfer belt **8**.

In FIG. **1**, the intermediate transfer device **15** includes the intermediate transfer belt **8** as the intermediate transferor, the five primary transfer rollers **9**Y, **9**M, **9**C, **9**K, and **9**S, a driving roller, a secondary transfer backup roller, multiple tension rollers, a cleaning backup roller, and a belt cleaner. The intermediate transfer belt **8** is supported by and entrained around multiple rollers to rotate in the direction indicated by arrow A**1** illustrated in FIG. **1** (clockwise) as one (the driving roller) of the multiple rollers rotates.

The five primary transfer rollers **9**Y, **9**M, **9**C, **9**K, and **9**S are disposed facing the photoconductor drums **1**Y, **1**M, **1**C, **1**K, and **1**S via the intermediate transfer belt **8**, respectively. Specifically, the five primary transfer rollers **9**Y, **9**M, **9**C, **9**K, and **9**S are pressed against the corresponding photoconductor drums **1**Y, **1**M, **1**C, **1**K, and **1**S via the intermediate transfer belt **8** to form primary transfer nips, respectively. A primary transfer power source applies respective primary transfer biases opposite to toner in polarity to the primary transfer rollers **9**Y, **9**M, **9**C, **9**K, and **9**S.

While rotating in the direction indicated by the arrow A**1** in FIG. **1**, the intermediate transfer belt **8** sequentially passes past the primary transfer nips between the photoconductor drums **1**Y, **1**M, **1**C, **1**K, and **1**S and the corresponding primary transfer rollers **9**Y, **9**M, **9**C, **9**K, and **9**S. Then, the single-color toner images on the photoconductor drums **1**Y, **1**M, **1**C, **1**K, and **1**S are primarily transferred and deposited one on another onto the intermediate transfer belt **8**.

Subsequently, the intermediate transfer belt **8** carrying the multicolor toner image reaches a position facing a secondary transfer roller **19**. A secondary transfer backup roller and the secondary transfer roller **19** press against each other via the intermediate transfer belt **8**, thereby forming a secondary transfer nip. The multicolor toner image on the intermediate transfer belt **8** is transferred onto a sheet P (a recording medium) conveyed to the secondary transfer nip (a second-

ary transfer process). At that time, toner that is untransferred onto the sheet P remains on a surface of the intermediate transfer belt **8**.

The surface of the intermediate transfer belt **8** reaches a position facing the belt cleaner. At this position, the belt cleaner collects the untransferred toner remaining on the intermediate transfer belt **8**.

Thus, a series of image transfer processes performed on the intermediate transfer belt **8** is completed.

Referring back to FIG. **1**, the sheet P is conveyed from a sheet feeder **26** (specifically, a sheet tray) disposed in a lower portion of an apparatus body **100**A of the image forming apparatus **100** to the secondary transfer nip through a sheet feeding path K**1**, along which a sheet feeding roller **27** and a registration roller pair **28** are disposed.

Specifically, the sheet feeder **26** contains a stack of multiple sheets P piled one on another. The sheet feeding roller **27** rotates counterclockwise in FIG. **1** to feed the sheet P on the top of the stack in the sheet feeder **26** toward a nip of the registration roller pair **28**.

The registration roller pair **28** (a timing roller pair) temporarily stops rotating, stopping the sheet P with a leading edge of the sheet P nipped in the registration roller pair **28**. The registration roller pair **28** resumes rotation to convey the sheet P to the secondary transfer nip, timed to coincide with the arrival of the multicolor toner image on the intermediate transfer belt **8**. Accordingly, the desired multicolor toner image is transferred onto the sheet P.

Subsequently, the sheet P, onto which the multicolor toner image is transferred at the secondary transfer nip, is conveyed to a fixing device **20**. In the fixing device **20**, a fixing belt and a pressing roller apply heat and pressure to the sheet P to fix the multicolor toner image on the sheet P (a fixing process).

The sheet P is conveyed through an ejection path K**2** and ejected by an ejection roller pair to the outside of the image forming apparatus **100**. The sheets P are sequentially stacked as output images on a stack tray.

Thus, a series of image forming processes performed by the image forming apparatus **100** is completed.

Next, a configuration and operation of the developing device **5**Y of the process cartridge **6**Y are described in further detail below with reference to FIG. **2**.

A casing of the developing device **5**Y to contain developer G is divided, at least partially, into two developer containing compartments by a wall. The developing device **5**Y includes the developing roller **51** as a developer bearer disposed facing the photoconductor drum **1**Y, a doctor blade **52** disposed facing the developing roller **51**, two conveying screws **55** respectively disposed in the developer containing compartments, a density sensor **56** to detect concentration (percentage) of toner in the developer G or toner density, and an opening **57** for supplying toner (developer) to the developer containing compartment. The developing roller **51** includes stationary magnets, a sleeve that rotates around the magnets, and the like. The developer containing compartments contain two-component developer G including carrier (carrier particles) and toner (toner particles).

With such a configuration, the developing device **5**Y operates as follows.

The sleeve of the developing roller **51** rotates in a direction indicated by arrow A**3** illustrated in FIG. **2**. The developer G is transported on the developing roller **51** by a magnetic field generated by the magnets. As the sleeve rotates, the developer G moves along the circumference of the developing roller **51**.

The percentage (concentration) of toner in the developer G (ratio of toner to carrier) in the developing device **5**Y is adjusted within a predetermined range. Specifically, according to the consumption of toner in the developing device **5**Y, the developer supply device **90**Y (illustrated in FIG. **3**) supplies toner (i.e., powder) from the toner container **32**Y (the developer container) to the developing device **5**Y (the developer containing compartment in particular). A configuration and operation of the toner container **32**Y and the developer supply device **90**Y are described in further detail later.

While being stirred with the developer G and circulated by the two conveying screws **55** in the developing device **5**Y (the developer containing compartments), the supplied toner is circulated between the two developer containing compartments, which is separated by the wall, in a longitudinal direction of the developing device **5**Y. The longitudinal direction of the developing device **5**Y is perpendicular to the surface of the paper on which FIG. **2** is drawn. The toner in two-component developer G is charged by friction with carrier and electrostatically attracted to the carrier. The toner is carried on the developing roller **51** together with the carrier by magnetic force generated on the developing roller **51**.

The developer G carried on the developing roller **51** is transported in the clockwise direction indicated by arrow A**3** in FIG. **2** to the doctor blade **52**. The doctor blade **52** adjusts the amount of developer G on the developing roller **51**, after which the developer G is transported to a developing range facing the photoconductor drum **1**Y. The toner in the developer G is attracted to the electrostatic latent image formed on the photoconductor drum **1**Y due to the effect of an electric field generated in the developing range. As the sleeve rotates, the developer G remaining on the developing roller **51** reaches an upper part of the developer containing compartment, drops from the developing roller **51**, and returns to the developer containing compartment.

The above-described electric field generated in the developing range is formed by potential difference between the exposure potential (the latent image potential) formed on the photoconductor drum **1**Y by emission of the laser beam L and a development bias applied to the developing roller **51** by a development power supply.

Next, a configuration and operation of the developer supply device **90**Y for yellow is described with reference to FIG. **3**.

In the present embodiment, the four other developer supply devices (the developer supply device **90**M for magenta, the developer supply device **90**C for cyan, the developer supply device **90**K for black, and the developer supply device **90**S for special color) have substantially the same configuration as the developer supply device **90**Y for yellow, except that the color (type) of the toner to be used is different. Therefore, descriptions of the developer supply devices **90**M, **90**C, **90**K, and **90**S are appropriately omitted, and only the developer supply device **90**Y for yellow is described.

In FIG. **3** (and FIG. **4**), suffixes Y, M, C, K, and S indicating respective colors to be attached to the reference numerals of the reservoir **81**, the sub-hopper **70**, and the conveyance pump **60** are omitted.

The developer supply device **90**Y rotates the toner container **32**Y as the developer container installed in a toner container mount **31** in a predetermined direction (direction indicated by arrow A**4** in FIG. **3**), discharges toner contained in the toner container **32**Y to the outside of the toner

container **32**Y, and guides the toner to the developing device **5**Y, thereby forming a toner supply route (a toner transport route).

In FIG. **3**, the arrangement direction of the toner container **32**Y, the developer supply device **90**Y, and the developing device **5**Y are changed for ease of understanding. In the present embodiment, the long axis of the toner container **32**Y and a part of the developer supply device **90**Y are perpendicular to the surface of the paper on which FIG. **3** is drawn (see FIG. **1**). In addition, the orientation and arrangement of the tube **95** (a conveyance path) are also illustrated in a simplified manner.

The yellow toner contained in the toner container **32**Y installed in the toner container mount **31** of the image forming apparatus **100** is supplied to the developing device **5**Y by the developer supply device **90**Y according to an amount of toner consumed in the developing device **5**Y.

Specifically, when the toner container **32**Y is set in the toner container mount **31** of the apparatus body **100**A, a bottle gear **37** of the toner container **32**Y meshes with a driving gear **110** of the apparatus body **100**A, and the cap chuck **92** of a cap holder **91** removes a cap **34**, which is for closing a toner outlet C, from the toner container **32**Y. Accordingly, the toner outlet C of the toner container **32**Y is opened, and the yellow toner is discharged from the toner container **32**Y through the toner outlet C.

In the developer supply device **90**Y, the reservoir **81** is disposed below the toner outlet C via a downward path **82**. A suction port **83** is disposed in the bottom portion of the reservoir **81** and coupled to one end of the tube **95** (the conveyance path) via a nozzle. The tube **95** as the conveyance path is formed of a flexible material with low affinity for toner, and the other end of the tube **95** is coupled to the conveyance pump **60** (a diaphragm pump). The conveyance pump **60** is coupled to the developing device **5**Y via the sub-hopper **70** and the conveyance pipe **98**.

With such a configuration of the developer supply device **90**Y, as the driving gear **110** is driven by a drive motor **115**, a container body **33** of the toner container **32**Y is rotated in a predetermined direction, thereby discharging toner from the toner outlet C of the toner container **32**Y. Accordingly, toner discharged from the toner outlet C of the toner container **32**Y falls through the downward path **82** and is stored in the reservoir **81**. As the conveyance pump **60** operates, the toner stored in the reservoir **81** is sucked from the suction port **83** and transported to the conveyance pump **60** and to the sub-hopper **70** via the tube **95**. The toner transported to the sub-hopper **70** is supplied into the developing device **5**Y via the conveyance pipe **98** extending in the vertical direction. That is, the toner in the toner container **32**Y is transported in the direction indicated by dashed arrows A**5** in FIG. **3**. In the present embodiment, unlike the tube **95**, the conveyance pipe **98** that couples between the sub-hopper **70** and the developing device **5**Y is formed of a hard resin material or a metal material which is hardly deformed.

Next, the conveyance pump **60** and the sub-hopper **70** of the developer supply device **90**Y are described in detail with reference to FIG. **4**.

In the present embodiment, the conveyance pump **60** is provided with the sub-hopper **70** as a single-piece unit.

Referring to FIG. **4**, the conveyance pump **60** in the present embodiment is the diaphragm pump (a positive displacement pump) and includes a diaphragm **61** (a rubber member), a case **62**, a motor **67**, a rotary plate **68**, an inlet check valve **63** and an outlet check valve **64**, seals **65** and **66** (elastic members), and the like. The conveyance pump **60** with such a configuration is relatively small and low in cost.

The case **62** and the diaphragm **61** together form a pump body of the conveyance pump **60**.

The case **62** is made of a resin material or a metal material having rigidity and functions as a main part (housing) of the pump body of the conveyance pump **60**. An inlet A for bringing the developer G together with air into the interior and an outlet B for discharging the developer G together with air from the interior are disposed in the case **62** (the pump body).

The diaphragm **61** is formed of a rubber material having elasticity and a low affinity for toner. The interior of the bowl-like portion functions as a variable volume portion W, and an arm **61***a* stands on the periphery thereof. An eccentric shaft **68***a* of the rotary plate **68** engages a hole of the arm **61***a*. The diaphragm **61** is joined with the case **62** without a gap, and the variable volume portion W of the diaphragm **61** and the inside of the case **62** are formed as one closed space inside the pump body of the conveyance pump **60** (i.e., the pump body). The diaphragm **61** expands and contracts by the rotary plate **68** (the eccentric shaft **68***a*) to be described later, thereby increasing and decreasing the internal volume. Therefore, the pump body of the conveyance pump **60** (i.e., the diaphragm **61** and the case **62**) alternately generate positive pressure and negative pressure.

The rotary plate **68** is disposed on the motor shaft of the motor **67**, and the eccentric shaft **68***a* is provided on the surface of the rotary plate **68** so as to stand upright at a position offset from the motor shaft (rotational center). The eccentric shaft **68***a* of the rotary plate **68** is inserted (fitted) into the hole formed in a tip of the arm **61***a* of the diaphragm **61**.

With such a configuration, as the motor **67** is driven by a controller **120**, the rotary plate **68** (the eccentric shaft **68***a*) rotates. Accordingly, the diaphragm **61** expands and contracts so as to increase and decrease the volume of the variable volume portion W periodically. With such expansion and contraction of the diaphragm **61**, the positive pressure and the negative pressure are alternately generated inside the pump body composed of the diaphragm **61** and the case **62**.

The inlet check valve **63** is disposed at the inlet A of the pump body (the case **62**). The inlet check valve **63** opens the inlet A when the negative pressure is generated inside the pump body (the diaphragm **61** and the case **62**) and closes the inlet A when the positive pressure is generated inside the pump body (the diaphragm **61** and the case **62**). The inlet check valve **63** is provided to face the inlet A from the inside of the pump body (the diaphragm **61** and the case **62**). The reservoir **81** is coupled to the inlet A of the conveyance pump **60** via the tube **95**.

The outlet check valve **64** is disposed at the outlet B of the pump body (the case **62**). The outlet check valve **64** closes the outlet B when the negative pressure is generated inside the pump body (the diaphragm **61** and the case **62**) and opens the outlet B when the positive pressure is generated inside the pump body (the diaphragm **61** and the case **62**). The outlet check valve **64** is provided to face the outlet B from the outside of the pump body (the diaphragm **61** and the case **62**). The sub-hopper **70** is coupled to the outlet B of the conveyance pump **60**.

With such a configuration and operation, as described above with reference to FIG. **3**, as the conveyance pump **60** operates, the toner stored in the reservoir **81** is sucked from the suction port **83** and transported into the sub-hopper **70** through the tube **95**. Specifically, when a hopper sensor **76**

of the sub-hopper **70** detects a shortage of toner in the sub-hopper **70**, the conveyance pump **60** (the motor **67**) is driven to supply toner from the reservoir **81** to the sub-hopper **70**.

When the hopper sensor **76** detects that the amount of toner in the sub-hopper **70** has not reached a predetermined amount and an insufficient state is detected, the conveyance pump **60** (the motor **67**) is intermittently driven in short cycles. As a result, the amount of toner transported by a first conveyance screw **71** and a second conveyance screw **72** in the sub-hopper **70** can catch up with the amount of toner supplied from the conveyance pump **60**, thereby preventing toner from stagnating in a part of the sub-hopper **70**.

Referring to FIG. **4**, the sub-hopper **70** includes the first conveyance screw **71**, the second conveyance screw **72**, the hopper sensor **76**, a supply motor **121** (see FIG. **3**), and the like. A supply port **73** communicating with the outlet B of the conveyance pump **60** is disposed above an upstream side of a first conveying path of the sub-hopper **70** in the direction of conveyance of toner. The first conveyance screw **71** is disposed in the first conveying path. A discharge port **74** is disposed under a downstream side of a second conveying path of the sub-hopper **70** in the direction of conveyance of toner and communicates with the developing device **5**Y via the conveyance pipe **98**. The second conveyance screw **72** is disposed in the second conveying path. Further, an exhaust port **75** for discharging air fed together with the toner from the conveyance pump **60** is disposed above the second conveying path of the sub-hopper **70**.

As described above, the hopper sensor **76** detects the insufficient state in which the amount of toner (developer) contained in the sub-hopper **70** is below the predetermined amount.

In the sub-hopper **70**, a downstream side of the first conveying path and an upstream side of the second conveying path in the direction of conveyance of toner communicate with each other (i.e. a communicating portion) on one end side in the longitudinal direction of the sub-hopper **70** perpendicular to the surface of the paper on which FIGS. **3** and **4** are drawn. The first conveying path and the second conveying path are separated from each other by the wall except the communicating portion.

The toner supplied into the sub-hopper **70** is conveyed through the first conveying path and the second conveying path in the sub-hopper **70** by the first conveyance screw **71** and the second conveyance screw **72** rotated by the supply motor **121** and is supplied from the sub-hopper **70** to the developing device **5**Y via the conveyance pipe **98**. Specifically, when the density sensor **56** of the developing device **5**Y detects a shortage of the toner concentration in the developer containing compartment (a circulation path in which the conveying screw **55** circulates the toner), the controller **120** rotates the first conveyance screw **71** and the second conveyance screw **72** of the sub-hopper **70**, thereby supplying the toner from the sub-hopper **70** to the developing device **5**Y.

As described above, in the present embodiment, the conveyance path extending from the reservoir **81** to the conveyance pump **60** is formed with the flexible tube **95**. Therefore, even when various components are installed in the space between the reservoir **81** and the conveyance pump **60**, the tube **95** can be installed avoiding those components to secure the conveyance path. Therefore, the toner container mount **31** of the toner container **32**Y can be freely laid out at a position away from the developing device **5**Y.

Next, referring to FIG. **3**, configurations of the toner container **32**Y and the developer supply device **90**Y are described below.

As described above, the toner container **32**Y includes the container body **33** and the cap **34** detachably attached to the toner outlet C of the container body **33**.

The bottle gear **37** that rotates together with the container body **33** and the toner outlet C are disposed on a head portion of the container body **33**. The bottle gear **37** meshes with the driving gear **110** of the apparatus body **100**A, and the driving gear **110** rotates the container body **33** with the bottle gear **37** in a predetermined direction. The toner outlet C is for discharging toner (powder) from the container body **33** to the downward path **82**.

The container body **33** includes a helical protrusion **33***a* protruding inward from an outer circumferential face to an inner circumferential face of the container body **33**. The helical protrusion **33***a* is for discharging toner from the container body **33** through the toner outlet C of the toner container **32**Y by rotation of the container body **33**.

The container body **33** can be produced together with the bottle gear **37** as a single unit by blow molding.

Referring to FIG. **3**, the cap holder **91** of the developer supply device **90**Y covers the head portion of the toner container **32**Y installed in the toner container mount **31** (the developer supply device **90**Y).

The cap holder **91** includes the cap chuck **92** for opening and closing the cap **34** in conjunction with the installation and removal operation of the toner container **32**Y and an opening-closing driver for driving the cap chuck **92**. The cap holder **91** is a part of the reservoir **81** as well as the downward path **82**. As the toner container **32**Y mounted on the toner container mount **31** is slid toward the cap holder **91** and the cap **34** reaches a position of the cap chuck **92**, the opening-closing driver operates so that the cap **34** is separated from the toner outlet C in a state in which the cap chuck **92** holds the cap **34** in conjunction with an operation of the toner container **32**Y that is slid further and pushed in. Thus, the toner outlet C of the toner container **32**Y is opened, and toner can be discharged from the toner outlet C. Further, in conjunction with the installation operation of the toner container **32**Y, the locking mechanism operates to lock the head portion of the toner container **32**Y so as not to be removed from the toner container mount **31**. At that time, the toner container **32**Y is secured to the developer supply device **90**Y (the toner container mount **31**) so that the toner outlet C side (head) of the toner container **32**Y is rotatable, and the container body **33** is rotatably supported on the toner container mount **31**.

In removal of the toner container **32**Y from the toner container mount **31**, the above-described processes are performed in reverse.

Toner discharged from the toner container **32**Y drops through the downward path **82** to the bowl-shaped reservoir **81** of the developer supply device **90**Y and stored therein. The reservoir **81** includes a toner sensor **86** and a stirrer. The conveyance pump **60** coupled to the suction port **83** of the reservoir **81** via the tube **95** sucks the toner in the reservoir **81** and conveys the toner through the tube **95**.

As described above, in the present embodiment, the toner discharged from the toner container **32**Y is not directly sucked by the conveyance pump **60** but is stored in the reservoir **81** to some extent. Then, the conveyance pump **60** sucks the necessary amount of toner stored in the reservoir **81**. Accordingly, such a configuration can minimize shortage of the toner sucked by the conveyance pump **60**.

The toner sensor **86** is disposed near the suction port **83** and indirectly detects a state in which toner contained in the toner container **32**Y is depleted (toner depletion), or a state close thereto (toner near depletion). Toner is discharged from the toner container **32**Y based on the detection result of the toner sensor **86**.

For example, a piezoelectric sensor or a light transmission sensor can be used as the toner sensor **86**. In the present embodiment, a piezoelectric sensor is used as the toner sensor **86**. The height of the detection surface of the toner sensor **86** is set so that the amount of toner (deposition height) deposited above the suction port **83** is a target value.

Based on the detection result of the toner sensor **86**, the controller **120** determines a drive timing and a drive duration of the drive motor **115** to rotationally drive the toner container **32**Y (the container body **33**). Specifically, when the controller **120** determines that there is no toner at the detection position based on the detection result of the toner sensor **86**, the drive motor **115** is driven for a predetermined time. On the other hand, when the controller **120** determines that the toner is present at the detection position based on the detection result of the toner sensor **86**, the drive motor **115** is stopped.

Next, referring to FIGS. **5** to **7**, the configuration and operation of the image forming apparatus **100** according to the present embodiment are described below.

As described above, in the image forming apparatus **100** according to the present embodiment, the sub-hopper **70**K for black and the sub-hopper **70**S for special color can be swapped. In other words, in the five sub-hoppers **70**Y, **70**M, **70**C, **70**K, and **70**S illustrated in FIGS. **1** and **6**A, the sub-hopper **70**K for black disposed in a rightmost installation position as a basic position and the sub-hopper **70**S for special color disposed in a leftmost installation position as a basic position are swapped. As a result, the sub-hopper **70**K for black can be disposed in the leftmost installation position, and the sub-hopper **70**S for special color can be disposed in the rightmost installation position as illustrated in FIG. **6**D.

In the present embodiment, since each of the conveyance pumps **60** is united with the corresponding one of the five sub-hoppers **70**, the conveyance pumps **60** are omitted in FIGS. **6**A to **6**D (and FIGS. **7** to **10**D).

As illustrated in FIGS. **5** to **6**D, the image forming apparatus **100** according to the present embodiment includes a cover **151** configured to open and close when the sub-hopper **70**K for black and the sub-hopper **70**S for special color are swapped.

The covers **151** are double doors hinged on hinges disposed left and right sides of the image forming apparatus **100** and opens around the hinges as the rotation centers to right and left, respectively. Further, the covers **151** function as a part of an exterior of the image forming apparatus **100**.

When normal image formation is performed, the covers **151** close as illustrated in FIG. **5** so as not to reveal the interior of the apparatus body **100**A. In addition to when the sub-hopper **70**K for black and the sub-hopper **70**S for special color are swapped, at the time of replacement of the process cartridge **6**Y, **6**M, **6**C, **6**K, or **6**S, during maintenance of the fixing device **20**, or when a jammed sheet P is removed, the covers **151** open around the hinges as the rotation centers from the state in FIG. **5** to the state illustrated in FIGS. **6**A to **6**D so as to reveal the interior of the apparatus body **100**A.

Referring to FIGS. **6**A to **7**, the cover **151** includes a holder **155** configured to temporarily place the sub-hopper **70**K for black when the sub-hopper **70**K for black and the sub-hopper **70**S for special color are swapped.

Specifically, as illustrated in FIG. **7**, the sub-hopper **70**K for black is a replacement removable component including a hook **70***a* (L-shaped plate). The holder **155** has an engagement portion **155***a*, with which the hook **70***a* engages. The engagement portion **155***a* is a substantially rectangular parallelepiped hole. An operator moves the sub-hopper **70**K for black downward so that a tip of the hook **70***a* engages with the engagement portion **155***a*, and the holder **155** holds the sub-hopper **70**K for black.

That is, the sub-hopper **70**S for special color is a removable component that is installable in and removable from the apparatus body **100**A as viewed based on the sub-hopper **70**S for special color. Meanwhile, the sub-hopper **70**K for black is the replacement removable component that is installable in and removable from a normal installation position (in the present embodiment, the leftmost installation position) of the sub-hopper **70**S for special color as the removable component. In the image forming apparatus **100** according to the present embodiment, as illustrated in FIG. **6**A, the sub-hopper **70**K for black as the replacement removable component is removably installed in a position (in the present embodiment, the rightmost installation position) different from the normal installation position of the sub-hopper **70**S for special color (the removable component) and the position of the holder **155** in normal time. In the image forming apparatus **100**, the sub-hopper **70**S for special color (the removable component) and the sub-hopper **70**K for black (the replacement removable component) containing different color toners (developers) each other can be swapped.

The covers **151** open and close when the sub-hopper **70**S for special color (the removable component) is installed in or removed from the apparatus body **100**A. In particular, the covers **151** open and close when the sub-hopper **70**S for special color (the removable component) and the sub-hopper **70**K for black (the replacement removable component) are swapped.

The holder **155** is configured to hold the sub-hopper **70**K for black at a position other than the installation position of the sub-hopper **70**S for special color in a state that the covers **151** open and the sub-hopper **70**S for special color is installed in the apparatus body **100**A as illustrated in FIG. **6**A. In the present embodiment, the holder **155** is disposed inside the cover **151** so as not to reveal the holder **155** when the covers **151** close as illustrated in FIG. **5**.

As illustrated in FIGS. **6**B and **6**C, in the image forming apparatus **100** according to the present embodiment, the sub-hopper **70**K for black as the replacement removable component held by the holder **155** inhibits the cover **151** from closing.

Specifically, when the cover **151** is about to close in a state in which the holder **155** holds the sub-hopper **70**K for black, the sub-hopper **70**K for black held by the holder **155** interferes with (contacts) a portion of the apparatus body **100**A enclosed by dashed circles in FIGS. **6**B and **6**C, thereby inhibiting the cover **151** from closing.

More specifically, the holder **155** protrudes from the inner surface of the cover **151**, and when the cover **151** closes, a recess (space) accommodates the holder **155** inside the apparatus body **100**A so as to enable the cover **151** to open and close. On the other hand, the sub-hopper **70**K for black held by the holder **155** further protrudes inward from the cover **151**. Accordingly, the recess (the space) does not accommodate the sub-hopper **70**K for black in the apparatus body **100**A, thereby inhibiting the cover **151** from closing.

As described above, for rearrangement in which the sub-hopper **70**S for special color (the removable component) and the sub-hopper **70**K for black (the replacement removable component) are swapped, the holder **155** is provided to temporarily place the sub-hopper **70**K for black. Therefore, when the sub-hopper **70**S for special color is replaced with the sub-hopper **70**K for black at the installation position of the sub-hopper **70**S for special color instead of the sub-hopper **70**S for special color, it does not take time and effort for the operator to secure space near the image forming apparatus **100**. Further, since the sub-hopper **70**K for black temporarily placed on the holder **155** inhibits the cover **151** from closing, the operator does not forget to install the sub-hopper **70**K for black after removing the sub-hopper **70**S for special color from the apparatus body **100**A. As a result, an efficiency to swap the sub-hopper **70**S for special color and the sub-hopper **70**K for black is improved.

In the image forming apparatus **100** according to the present embodiment, when the holder **155** holds the sub-hopper **70**K for black as the replacement removable component, the sub-hopper **70**S for special color as the removable component can be removed from or installed in the apparatus body **100**A.

Specifically, when the sub-hopper **70**S for special color is removed from or installed in the apparatus body **100**A in a state in which the holder **155** holds the sub-hopper **70**K for black, the sub-hopper **70**S for special color does not interfere with (contact) the sub-hopper **70**K for black held by the holder **155** to remove and install the sub-hopper **70**S for special color as illustrated in FIGS. **6**B and **6**C.

More specifically, the holder **155** is far enough from the installation positions of the five sub-hoppers **70**Y, **70**M, **70**C, **70**K, and **70**S. In the present embodiment, the holder **155** is disposed below the sub-hoppers **70**Y, **70**M, **70**C, **70**K, and **70**S. Therefore, the sub-hopper **70**K held by the holder **155** does not overlap trajectories of the removal and installation of the sub-hopper **70**S at the basic installation positions for the sub-hopper **70**S for special color (the leftmost installation position) and for the sub-hopper **70**K for black (the rightmost installation position).

As a result, the efficiency to swap the sub-hopper **70**S for special color and the sub-hopper **70**K for black is further improved.

In summary, referring to FIGS. **6**A to **6**D, descriptions are provided of processes of swapping the sub-hopper **70**S for special color and the sub-hopper **70**K for black from the basic arrangement by the operator.

As illustrated in FIG. **6**A, the covers **151** open from the closed state in FIG. **5**, and the five sub-hoppers **70**Y, **70**M, **70**C, **70**K, and **70**S and the holder **155** are revealed. The operator removes the sub-hopper **70**K for black from the apparatus body **100**A in a direction indicated by arrow A**6** in FIG. **6**A and moves the removed sub-hopper **70**K for black in a direction indicated by dashed arrow A**7** to temporarily place the sub-hopper **70**K for black on the holder **155** as illustrated in FIG. **6**B. Then, the operator removes the sub-hopper **70**S for special color from the apparatus body **100**A in a direction indicated by arrow A**8** in FIG. **6**B.

The operator installs the removed sub-hopper **70**S for special color in the rightmost installation position in the apparatus body **100**A as indicated by arrow A**9** in FIG. **6**C.

The operator removes the sub-hopper **70**K for black from the holder **155** and installs the removed sub-hopper **70**K for black in the leftmost installation position in the apparatus body **100**A as indicated by arrow A**10** in FIG. **6**D.

Finally, the covers **151** close.

Processes of returning from the arrangement illustrated in FIG. **6**D to the basic arrangement illustrated in FIG. **6**A is performed in reverse manner to the above-described processes.

In the present embodiment, the one holder **155**, on which the sub-hopper **70**K for black is temporarily placed, is provided to facilitate the swap process described above. Alternatively, in addition to the holder **155** to temporarily place the sub-hopper **70**K for black, another holder can be provided to temporarily place the sub-hopper **70**S for special color. Alternatively, the sub-hopper **70**S for special color can include a hook **70***a* and can be temporarily placed on the holder **155**.

In the present embodiment, the holder **155** is used for temporary placement when the sub-hopper **70**K for black and the sub-hopper **70**S for special color are swapped. Alternatively, another holder can be provided for temporary placement when the process cartridge **6**K for black and the process cartridge **6**S for special color are swapped, or the holder **155** can be shared as the holder for the process cartridge **6**K. Further, the sub-hopper **70**K and the process cartridge **6**K for black united as a single unit can be simultaneously removed from and installed in the apparatus body **100**A, and the sub-hopper **70**S and the process cartridge **6**S for special color united as a single unit can be simultaneously removed from and installed in the apparatus body **100**A.

In the present embodiment, the sub-hopper **70**S for special color is the removable component, and the sub-hopper **70**K for black is the replacement removable component. Alternatively, the sub-hopper **70**K for black can be the removable component, and the sub-hopper **70**S for special color can be the replacement removable component.

FIGS. **8**A to **8**B are schematic views illustrating a part of processes of swapping the sub-hoppers **70**K and **70**S in the apparatus body **100**A according to a first variation of the present disclosure, corresponding to FIGS. **6**A and **6**B illustrating the above-described embodiment.

As illustrated in FIGS. **8**A and **8**B, in the image forming apparatus **100** according to the first variation of the present disclosure, the holder **155** to temporarily place the sub-hopper **70**K for black (the replacement removable component) is disposed inside the apparatus body **100**A of the image forming apparatus **100**, not inside the cover **151**.

When the cover **151** closes in a state in which the holder **155** holds the sub-hopper **70**K for black, the sub-hopper **70**K for black held by the holder **155** interferes with (contacts) a portion of the cover **151** enclosed by the dashed circle in FIG. **8**B, thereby inhibiting the cover **151** from closing.

The holder **155** is far enough from the installation positions of the five sub-hoppers **70**Y, **70**M, **70**C, **70**K, and **70**S. Therefore, the sub-hopper **70**K held by the holder **155** does not inhibit the removal and installation of the sub-hopper **70**K at the basic installation positions for the sub-hopper **70**S for special color (the leftmost installation position) or for the sub-hopper **70**K for black (the rightmost installation position).

With such a configuration according to the first variation, the efficiency to swap the sub-hopper **70**S for special color and the sub-hopper **70**K for black is improved, similarly to the above described embodiment.

FIG. **9** is a schematic perspective view illustrating a partial configuration of an image forming apparatus **100** according to a second variation of the present disclosure. FIGS. **10**A to **10**D are schematic views illustrating processes of swapping the sub-hoppers **70**K and **70**S in the image

forming apparatus **100**, corresponding to FIGS. **6**A and **6**D in the above-described embodiment.

As illustrated in FIGS. **9** to **10**D, in the image forming apparatus **100** according to the second embodiment, the sub-hopper **70**S for special color (the removable component) and the sub-hopper **70**K for black (the replacement removable component) containing different color toners (developers) can be swapped in a state in which the sub-hoppers **70**S and **70**K are coupled to the reservoirs **81**S and **81**K of the apparatus body **100**A via tubes **95**S and **95**K, through which toner (developer) is transferred, respectively.

Accordingly, the toner container **32**S and the reservoir **81**S for special color and the toner container **32**K and the reservoir **81**K for black is not swapped. The sub-hopper **70**S for special color and the sub-hopper **70**K for black are rearranged (swapped) without being decoupled from the apparatus body **100**A, in a state in which the sub-hoppers **70**S and **70**K are coupled to the reservoir **81**S and **81**K of the apparatus body **100**A via the tubes **95**S and **95**K, respectively as illustrated in FIGS. **10**A to **10**D.

As illustrated in FIG. **9**, the image forming apparatus **100** according to the second variation includes a tube housing **108** to accommodate a part of the tubes **95**K and **95**S. The tubes **95**K and **95**S are wound or folded without buckling in the tube housing **108**.

Specifically, both the tube **95**S for special color and the tube **95**K for black are long enough to change the layouts thereof in conjunction with the swap of the sub-hoppers **70**S and **70**K. Therefore, after the sub-hoppers **70**S and **70**K are swapped, the length of the tubes **95**K and **95**S becomes excessive as illustrated in FIG. **10**D.

As illustrated in FIG. **9**, the tube housing **108** can reel in a portion of the tubes **95**S and **95**K without buckling and therefore can eliminate slackness of the tubes **95**S and **95**K and prevent entanglement of the tubes **95**S and **95**K without reducing ability to transport toner.

More specifically, as illustrated in FIG. **9**, the tube housing **108** is a cylindrical member having a core shaft **108***b* therein, around which the tubes **95**S and **95**K wind once inside a cylindrical portion **108***a*. The tube housing **108** is shaped to allow the size of winding of the tubes **95**S and **95**K to change. That is, when the distances between both ends (an end portion coupled to the supply source and an end portion coupled to the supply destination) of the tubes **95**S and **95**K are short (normal time in which the sub-hoppers **70**S and **70**K are not swapped), the size of winding of the tubes **95**S and **95**K circling around the core shaft **108***b* is enlarged to be closer to the inner wall of the cylindrical portion **108***a*. On the other hand, when the distances between both ends of the tubes **95**S and **95**K are long (when the sub-hoppers **70**S and **70**K are swapped), the size of winding of the tubes **95**S and **95**K circling around the core shaft **108***b* is reduced so that the tubes **95**S and **95**K becomes closer to the core shaft **108***b*.

It is to be noted that the inner wall of the cylindrical portion **108***a* of the tube housing **108** has a curvature larger than the maximum curvature at which buckling occurs in the tubes **95**S and **95**K. The tube housings **108** are separated from each other to accommodate the tube **95**S for special color and the tube **95**K for black, respectively.

With such a configuration according to the second variation, the efficiency to swap the sub-hopper **70**S for special color and the sub-hopper **70**K for black is improved, similarly to the above-described embodiment.

Note that, when the length of the tube **95**S for special color is shorter than the tube **95**K for black so that the sub-hopper **70**S for special color does not reach the holder **155**, the operator does not accidentally place the sub-hopper **70**S for special color on the holder **155**. Therefore, the operator can smoothly swap the sub-hoppers **70**S and **70**K in the processes illustrated in FIGS. **10**A to **10**D.

FIGS. **11**A to **11**D are schematic views illustrating processes of replacing a present fixing device **20**A with a new fixing device **20**B according to a third variation of the present disclosure, corresponding to FIGS. **6**A and **6**D in the above-described embodiment.

According to the third variation, for simply replacing the present fixing device **20**A (a removable component), the new fixing device **20**B (a replacement removable component) is installed in a position, in which the present fixing device **20**A (the removable component) is installed, instead of the present fixing device **20**A (the removable component). These replacement processes are different from the swap processes in the above-described embodiments. In the swap processes, for rearranging the sub-hopper **70**S for special color (the removable component), the sub-hopper **70**K for black (the replacement removable component) is installed in the position, in which the sub-hopper **70**S for special color (the removable component) is installed, instead of the sub-hopper **70**S for special color (the removable component). Accordingly, in the third variation, the present fixing device **20**A (the removable component) has the same configuration and function as the new fixing device **20**B (a replacement removable component). Note that, these replacement process is performed when the present fixing device **20**A (the removable component) reaches the end of life.

Next, a description is provided of a series of processes for replacement of the fixing device **20**A by the operator according to the third variation, with reference to FIGS. **11**A to **11**D.

As illustrated in FIG. **11**A, the covers **151** open from the closed state in FIG. **5**, and the present fixing device **20**A and the holder **155** are revealed.

The operator temporarily places the new fixing device **20**B for replacement on the holder **155** as indicated by dashed arrow in FIG. **11**B. At that time, the new fixing device **20**B held by the holder **155** interferes with (contacts) a portion of the apparatus body **100**A enclosed by dashed circles illustrated in FIGS. **11**B and **11**C and inhibits the cover **151** from closing. Further, the new fixing device **20**B held by the holder **155** does not inhibit the operator from removing and installing the present fixing device **20**A from and in the image forming apparatus **100**.

The operator removes the present fixing device **20**A from the apparatus body **100**A in a direction indicated by arrow in FIG. **11**C.

Then, the operator takes the new fixing device **20**B for replacement from the holder **155** and installs the new fixing device **20**B in the apparatus body **100**A as illustrated in FIG. **11**D.

Finally, the covers **151** close.

With such a configuration in the third variation, problems are prevented that it takes time and effort for the operator to secure space and that the operator forgets to install the new fixing device **20**B for replacement after removing the present fixing device **20**A from the apparatus body **100**A. Therefore, an efficiency for replacing the fixing device **20** is improved.

Note that, in the third variation, examples of the removable component and the replacement removable component are the fixing devices **20**A and **20**B. Alternatively, the present disclosure can be adopted to any unit or component other than the fixing device **20**, similarly to the third variation.

As described above, the holder **155** is configured to hold the sub-hopper **70**K for black (the replacement removable component) at a position other than the normal installation position of the sub-hopper **70**S for special color (the removable component) in a state in which the covers **151** open and the sub-hopper **70**S for special color (the removable component) is installed in the apparatus body **100**A. The sub-hopper **70**K for black is installable in and removable from the normal installation position of the sub-hopper **70**S for special color. The sub-hopper **70**K for black as the replacement removable component held by the holder **155** inhibits the cover **151** from closing.

Therefore, it does not take time and effort for the operator to secure space for temporary placement of the sub-hopper **70**K for black. Further, the operator does not forget to install the sub-hopper **70**K for black after removing the sub-hopper **70**S for special color from the apparatus body **100**A.

In the embodiments described above, the photoconductor drum **1**Y serving as the image bearer, the charger **4**Y, the developing device **5**Y, and the cleaner **2**Y are united as the process cartridge **6**Y. However, the present disclosure is not limited to the embodiments described above and applied to the image forming apparatus **100** in which the developing device **5**Y and the photoconductor drum **1**Y are removably installed as a single unit, respectively.

It is to be noted that the term "process cartridge" used in the present specification means a unit including an image bearer and at least one of a charger to charge the image bearer, a developing device to develop latent images on the image bearer, and a cleaner to clean the image bearer united together and is designed to be removably installed together in the apparatus body of the image forming apparatus.

In the above-described embodiments, the present disclosure is adopted to the image forming apparatus **100** in which the developer supply devices **90**Y, **90**M, **90**C, **90**K, and **90**S include the cap holder **91**, the reservoir **81**, the conveyance pump **60**, the sub-hopper **70**, the tube **95**, and the conveyance pipe **98**, but the configuration of the developer supply device **90** is not limited thereto.

In the above-described embodiments, the present disclosure is adopted to the image forming apparatus **100** in which the toner containers **32**Y, **32**M, **32**C, **32**K, and **32**S are substantially cylindrical, and the bodies of the toner containers **32**Y, **32**M, **32**C, **32**K, and **32**S are rotatably driven, but the configuration of the toner container is not limited thereto.

In the above-described embodiments, the present disclosure is adopted to the image forming apparatus **100** in which the plurality of photoconductor drums **1**Y, **1**M, **1**C, **1**K, and **18** (the image bearers) are arranged side by side along the rotation direction of the intermediate transfer belt **8** (the intermediate transferor) that moves in the predetermined rotation direction. Meanwhile, the present disclosure can also be applied to an image forming apparatus employing a transfer conveyance belt, in which the plurality of image bearers is arranged side by side along the direction of movement of the sheet that moves with the transfer conveyance belt in the predetermined rotation direction.

In such configurations, effects similar to those described above are also attained.

The above-described embodiments are illustrative and do not limit the present disclosure. Thus, numerous additional modifications and variations are possible in light of the above teachings. It is therefore to be understood that within the scope of the present disclosure, the present disclosure may be practiced otherwise than as specifically described herein. The number, position, and shape of the components of the image forming apparatus described above are not limited to those described above.

What is claimed is:

1. An image forming apparatus comprising:

an apparatus body;

a removable component configured to be removably installed in an installation position in the apparatus body;

a cover configured to open and close when the removable component is installed in or removed from the installation position;

a replacement removable component configured to be installable in and removable from the installation position in which the removable component is installed; and

a holder configured to hold the replacement removable component at a different position from the installation position when the removable component is installed in the installation position and the cover opens,

the replacement removable component held by the holder configured to inhibit the cover from closing.

2. The image forming apparatus according to claim **1**,

wherein the removable component is installable in and removable from the apparatus body when the holder holds the replacement removable component.

3. The image forming apparatus according to claim **1**,

wherein the holder is attached to the cover.

4. The image forming apparatus according to claim **1**,

wherein the holder is disposed inside the apparatus body.

5. The image forming apparatus according to claim **1**,

wherein the replacement removable component is installed in another installation position different from the installation position of the removable component and a position of the holder, and

wherein the removable component and the replacement removable component are swappable with each other.

6. The image forming apparatus according to claim **5**,

wherein the removable component and the replacement removable component employ developers of different colors from each other.

7. The image forming apparatus according to claim **6**, further comprising tubes configured to convey the developers,

wherein the removable component and the replacement removable component are swappable with each other in a state in which the removable component and the replacement removable component are coupled to the apparatus body via the tubes, respectively.

8. The image forming apparatus according to claim **1**,

wherein the replacement removable component includes a hook, and the holder has an engagement portion engageable with the hook.

9. The image forming apparatus according to claim **1**,

wherein the replacement removable component held by the holder interferes with the apparatus body or the cover and inhibits the cover from closing, and

wherein the replacement removable component held by the holder does not interfere with the removable component and does not inhibit the removable component from being installed in and removed from the apparatus body.

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